On the Provision of Global Public Goods

Experimental Evidence on Climate Change Mitigation Issues

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To my parents

Summary

Climate change has become a growing concern worldwide. The projected consequences include rising average surface temperature, sea level rise, melting glaciers, changing precipitation patterns, more extreme weather events and changes in ecological and economic systems. However, climate change mitigation is a global public good and, therefore, suffers from underprovision due to free-riding incentives. The economics of climate protection – costs and benefits, uncertainty, and the regional distribution of effects – make the provision thereof one of the biggest challenges for the international community. Furthermore, the historical development of the problem and countries' differences in responsibility, wherewithal, and vulnerability give leeway for different perceptions of fair burden sharing.

This thesis provides an experimental and theory based analysis of the voluntary provision of global public goods with a special focus on climate change mitigation. It comprises a selection of essays on public good provision and the elicitation of other-regarding preferences. Each chapter provides a stand-alone analysis featuring an introduction to the research question of interest, the contribution to existing literature and the methodological approach. The dissertation is structured along two thematic lines: Following a general introduction, *Part I* presents the results of three lab experiments simulating the climate change mitigation problem. The first two chapters in this part analyze a dilemma game and test theory on the formation of coalitions with different institutions implemented in the coalition. The third chapter examines a coordination game in which players face catastrophic climate change if their emission abatement falls short of a certain threshold. Players in this game differ with respect to wealth and historical responsibility and they have the opportunity to communicate via non-binding pledges. *Part II* investigates other-regarding preferences as a motivation to contribute to public goods. The first chapter in this part presents the results of an online experiment that elicits the social preferences of climate negotiators. The negotiators' behavior is compared to corresponding student behavior in lab experiments. The experiment, furthermore, considers cross-country differences between negotiators. The following two chapters present the results of a framed field experiment with citizens who had the opportunity to donate for various charitable purposes. Using a non-student subject pool allows the analysis of socio-economic variables as potential determinants of the willingness to contribute to a public good. These studies provide also some

methodological insights by suggesting improvement opportunities for the elicitation of other-regarding preferences by simple experimental games.

The experiments in the second part show that climate negotiators and citizens are willing to share their endowments with strangers even under completely anonymous conditions. Therefore, under certain conditions people may also be willing to pay for climate protection. Although we do not know countries' guiding principles in international climate negotiations, these findings suggest that governments may not act completely selfishly but may move beyond the unilaterally rational level. Therefore, theoretical as well as experimental findings should be taken into account in the analysis of climate negotiations and the respective policy advice.

In this spirit, the experiments in the first part analyze the consequences of real (and possibly other-regarding) preferences for the players' ability to solve the dilemma or coordination problem. The most important finding stems from the experiments that allow for the voluntary formation of coalitions to overcome the free-rider problem: Independently from the institution in place, the players do not come close to the social optimum. The implications thereof are important for the ongoing policy discussions. The widely believed hypothesis that the United Nations *process*, involving many different countries each endowed with a veto, impedes effective cooperation is not supported by the experimental data. The fact that even small groups consisting of few symmetric players under different institutions, are not able to secure the efficient public good provision level, indicates that, first and foremost, the prevailing free-riding incentives impede effective cooperation.

The experimental literature in the field of coalition formation and catastrophe avoidance is still at the beginning and needs further development. The experimental results, so far, support the view that small changes in the process might not be enough, but that more radical changes might be needed: The 'targets and timetables' approach as implemented in all previous climate resolutions does not show great promise for reducing global greenhouse gas emissions. The prospects for an effective global agreement are thin from all perspectives: real world experience, theory, and experiments. Therefore, besides working on a global top-down agreement, countries should aim for bottom-up solutions such as sectoral or small multi-track agreements.

Zusammenfassung

Der Klimawandel wird mittlerweile weltweit als ein ernstzunehmendes Problem wahrgenommen. Die zu erwartenden Folgen des Klimawandels umfassen durchschnittlich steigende Oberflächentemperatur, steigende Meeresspiegel, schmelzende Gletscher, veränderte Niederschlagsmuster, zunehmende Extremwetterereignisse sowie Veränderungen in Öko- und Wirtschaftssystemen. Der Schutz des Klimas ist jedoch ein globales öffentliches Gut und leidet daher unter Freifahreranreizen. Die Ökonomie des Klimaschutzes – Kosten und Nutzen, Unsicherheit und regionale Verteilung der Effekte – macht die Vermeidung von Treibhausgasemissionen zu einer der größten Herausforderungen für die internationale Gemeinschaft. Darüber hinaus führen die historische Entwicklung des Problems und die Unterschiede zwischen Staaten hinsichtlich ihrer Verantwortung, ihrer wirtschaftlichen Leistungsfähigkeit und ihrer Betroffenheit durch den Klimawandel zu verschiedenen Auffassungen von fairer Lastenverteilung.

Die vorliegende Dissertation bietet eine experimentelle und theoretisch fundierte Analyse der freiwilligen Bereitstellung globaler öffentlicher Güter mit besonderem Schwerpunkt auf Klimaschutz. Sie enthält eine Auswahl an Aufsätzen zur Bereitstellung öffentlicher Güter und zur Erhebung sozialer Präferenzen. Jedes Kapitel enthält eine eigenständige Analyse, die eine Einleitung zur entsprechenden Fragestellung, ihren Beitrag zur bestehenden Literatur und den methodischen Ansatz aufweist. Die Struktur der Dissertation folgt zwei thematischen Linien: Nach einer allgemeinen Einleitung werden in *Teil I* drei Experimente präsentiert, in denen das Klimaproblem im Labor simuliert wird. Die beiden ersten Kapitel dieses Teils analysieren ein Dilemmaspiel und testen Theorien zur Koalitionsbildung mit verschiedenen Institutionen, die die Emissionsminderung innerhalb der Koalition bestimmen. Das dritte Kapitel widmet sich der Untersuchung eines Koordinationsspiels, in dem die Spieler katastrophalen Klimaschäden ausgesetzt sind, wenn ihre Emissionsminderungen unter eine bestimmte Grenze fallen. Die Spieler unterscheiden sich hinsichtlich ihrer historischen Verantwortung für das Problem und ihrer Anfangsausstattung. Im Spiel haben sie die Möglichkeit, über unverbindliche Absichtserklärungen miteinander kommunizieren und so das Koordinationsproblem zu lösen.

In *Teil II* der Arbeit werden soziale Präferenzen als potentielle Determinanten für individuelle Beiträge zu öffentlichen Gütern untersucht. Im ersten Kapitel dieses Teils werden die Ergebnisse eines Online-Experiments zur Erhebung der sozialen Präferenzen von Klimaverhandlern vorgestellt. Das Verhalten der Verhandler wird mit Verhalten von Studenten in gleichartigen Laborexperimenten verglichen. Weiterhin geht es in diesem Experiment um regionsspezifische Unterschiede zwischen Verhandlern. In den zwei nachfolgenden Kapiteln werden die Ergebnisse eines Spendenexperiments mit nicht-studentischen Versuchspersonen vorgestellt. Ein Ziel ist dabei, sozioökonomische Variablen als potentielle Bestimmungsfaktoren für die Bereitschaft, zu einem öffentlichen Gut beizutragen, zu analysieren. Diese Studien liefern auch methodische Einblicke, indem sie Verbesserungsmöglichkeiten für die Erhebung sozialer Präferenzen durch einfache experimentelle Spiele aufzeigen.

Die Experimente im zweiten Teil zeigen, dass sowohl Klimaverhandler als auch Bürger bereit sind, selbst unter vollständig anonymen Bedingungen ihr Budget mit Fremden zu teilen. Dies deutet darauf hin, dass unter bestimmten Bedingungen Menschen bereit sein könnten, etwas für Klimaschutz zu bezahlen. Dies könnte Regierungen wiederum die Möglichkeit geben, mehr Klimaschutz als das unilateral rationale und eigennützige Niveau zu betreiben. Aus diesem Grund sollten sowohl theoretische als auch experimentelle Erkenntnisse bei der Analyse der Klimaverhandlungen und der entsprechenden politischen Implikationen betrachtet werden.

In diesem Sinne demonstrieren die Experimente im ersten Teil der Arbeit die Folgen realer (möglicherweise sozialer) Präferenzen für die Fähigkeit der Spieler, das Dilemma- oder Koordinationsproblem zu lösen. Die wichtigsten Erkenntnisse stammen aus den Experimenten zur freiwilligen Koalitionsbildung: Unabhängig von der Institution, die innerhalb der Koalition eingesetzt wird, kommen die Spieler nicht an das soziale Optimum heran. Dies hat wichtige Implikationen für die internationale Klimapolitik. Die weitverbreitete Hypothese, dass vor allem der *Prozess* der Vereinten Nationen mit vielen unterschiedlichen Staaten, die jeweils ein Vetorecht haben, eine effektive Kooperation verhindert, wird von den experimentellen Daten nicht gestützt. Dass auch kleine Gruppen von wenigen symmetrischen Spielern mit unterschiedlichen Institutionen nicht die effiziente Lösung umsetzen können, deutet darauf hin, dass die vorhandenen Freifahreranreize das Haupthindernis für effektive Kooperation sind.

Die experimentelle Literatur in den Bereichen Koalitionsbildung und Vermeidung von katastrophalen Klimaschäden steht noch am Anfang und bedarf weiterer Entwicklung. Die bisherigen Ergebnisse unterstützen die Ansicht, dass kleine Änderungen im Prozess nicht ausreichen könnten, sondern dass radikale Änderungen vorgenommen werden müssten: Der Ansatz von ‚Reduktionszielen und Zeitplänen', wie er in allen bisherigen Klimabeschlüssen umgesetzt ist, erscheint nicht zielführend, um die globalen Treibhausgasemissionen nachhaltig zu begrenzen. Die Erfolgsaussichten für ein effektives globales Abkommen sind aus allen Perspektiven gering: reale Erfahrungen, Theorie und Experimente. Daher sollten Staaten neben den Verhandlungen um ein globales ‚top-down' Abkommen parallel ‚bottom-up' Lösungen wie beispielsweise sektorale Abkommen oder ein System von mehreren kleinen Abkommen anstreben.

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1 General introduction

The change of the global climate has become a growing concern worldwide. The projected consequences include rising average surface temperature, sea level rise, melting glaciers, changing precipitation patterns, more extreme weather events, and changes in ecological and economic systems. In its last assessment report, the Intergovernmental Panel on Climate Change (IPCC) reemphasized the urgency of political action by stating that "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century" (IPCC 2007). However, climate change mitigation is a global public good. If provided, no country can be excluded from enjoying the benefits of mitigation and a country enjoying the benefits does not impinge on the consumption opportunities of other countries. Like many global public goods, climate change mitigation is universally desirable but suffers from free-riding incentives because its provision is beneficial for every country, even for those that do not help providing it. The economics of climate protection make the provision thereof one of the biggest challenges for the international community. In particular, the following characteristics appear to be critical: First, reducing global greenhouse gas emissions depends on the aggregate effort of all countries. Contributions by individual countries do hardly matter and they do not induce other countries to join them. Second, it is costly to reduce greenhouse gas emissions substantially. Doing so will increase other risks, such as those associated with the expansion of nuclear power or the use of carbon capture and storage, and will divert investments in other causes. Third, climate change damages will be mostly gradual, giving agents the time to adapt. Catastrophic damages are highly uncertain and will probably take centuries to unfold. Fourth, different countries will be affected in different ways. Some regions may benefit while others may lose. The countries most likely to be adversely affected are the poorest countries which are least able to mitigate and adapt to climate change. For these reasons, countries either do not have the incentive or the wherewithal to act (Barrett 2007).

There is another obstacle that has received less attention in the economic literature: the perceptions of fair burden sharing. Since the beginning of the industrial era, greenhouse gas concentrations in the atmosphere have been increased by about one third. Average global temperature has also risen and according to the IPCC most of this warming is

attributable to human activities. More precisely, these effects have been caused by the economic activities of the industrialized countries. The differences in responsibility together with differences in vulnerability and wherewithal pose the question how the burden of climate change mitigation is to be shared between countries, particularly between the developed countries and the newly industrializing economies. If the burden sharing is to be accepted by all countries, it obviously needs to be perceived as fair. However, different parties in climate negotiations refer to different fairness principles of burden sharing. Developing countries often call attention to the fact that industrialized countries have much higher per capita CO_2 emissions. They often refer to the *egalitarian principle*, which may be interpreted in the sense that every citizen has the same right to pollute. Consequently, they demand an equalization of per capita emissions at least in the long run. Other equity rules refer either to the responsibility or the ability to cope with the problem of climate change. The *polluter-pays rule*, for example, claims that abatement costs should be distributed in proportion to a country's share in global emissions. Another principle, in the past favored mainly by the United States, is the *sovereignty rule*. It represents the idea of an equal percentage emission reduction for all countries, implying substantial abatement efforts for important growing developing countries such as China or India. All these principles stem from different views on equity and fairness. These different views seem to reflect a 'self-serving' bias of fairness perceptions: Countries prefer an equity principle that is in their best interest, meaning that the implementation of that principle would generate least costs for them (Lange et al. 2010).

Against this background, what has actually been done to reduce greenhouse gas emissions? Although the topic has received a lot of public attention and a huge amount of diplomatic energy in international climate negotiations, so far only little has been done to mitigate global climate change. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) established the objective of the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous climate change (UNFCCC 1992). The Convention came into force two years later. By the end of 1997, the Kyoto Protocol to the Framework Convention was negotiated (UNFCCC 1997). Subsequent negotiations filled in many of the agreement's details. The treaty was completed by November 2001 and came into force in February 2005. The Kyoto Protocol commits industrialized countries to reduce their greenhouse

gas emissions by 5.2% on average between 2008 and 2012 relative to the 1990 levels. Though it principally allows the commitments to be fulfilled economically through the use of flexible market-based mechanisms, the agreement has been criticized for several design faults: It imposes only short-term emission reduction targets for only a limited number of countries. Some of these countries are given 'hot air', i.e. targets that allow emissions beyond the business-as-usual scenario. Kyoto does not deter non-participation and it does not promote compliance. As a consequence, the United States withdrew from the agreement and Canada is not complying with the agreement. A follow-up agreement was negotiated in Copenhagen at the end of 2009, the Copenhagen Accord. The Accord allows participating countries to express their emission reduction targets in a variety of ways. For example, developed countries pledged different reduction targets relative to different base years by 2020. The pledges of developing countries include reduction targets relative to business-as-usual projections, reductions in emissions per unit of gross domestic product, expansion in forest cover, and investments in energy efficiency. Though the Accord tries to overcome one of the critical shortcomings of Kyoto – the exclusion of developing countries – the agreement is not legally binding and the individual pledges cannot be expected to improve much upon unilateralism. The voluntary pledges of the participating countries were officially adopted at the subsequent climate conference in Cancún in December 2010. The negotiations of an international agreement that involves legally binding and long-term emission reduction targets were postponed.

Many alternative climate policy architectures have been suggested. They try to overcome the Kyoto Protocol's shortcomings, for example, by incorporating emission reduction targets that are modest in short-term but become more ambitious over time, mechanisms intended to increase developing country participation, and market-based instruments. Some proposals are quite radical and drop the approach of targets and timetables entirely. More recent proposals suggest bottom-up approaches, involving for example agreements between smaller groups of countries, sectoral agreements, or systems of smaller multi-track agreements (e.g. Baron et al. 2008, Barrett 2008, Bodansky 2010). The main problem is that the approaches seeking for cost-effective mitigation are unlikely to induce countries' participation and compliance while the approaches addressing these issues are not cost-effective (Barrett and Stavins 2003).

Conceptual approach

This thesis provides an experimental and theory based analysis of the voluntary provision of global public goods with a special focus on climate change mitigation. The conceptual approach is twofold: In a nutshell, the first conceptual dimension deals with games designed to simulate the climate change problem. The second dimension deals more broadly with other-regarding behavior which cannot be explained by the standard economic theory and which may be analyzed in experimental games. In the following, both dimensions will be explained in greater detail.

The *first* conceptual dimension aims at analyzing strategies and outcomes in public good games. The game theoretical models on public good provision and international environmental agreements (IEA) constitute the backbone of this part by providing predictions of agents' behavior. Climate change mitigation is usually modeled as an n-player dilemma game, in which players decide on how much of a given endowment they want to contribute to the public good. The players in the games are the countries themselves as represented by their national governments. Countries are assumed to be monolithic actors that in most cases care only about their own payoff. Players in the games must choose a strategy which leads to a certain outcome and a certain payoff for each player. The payoffs are utility measures and can be thought of as being expressed in monetary terms or welfare. The players must act without knowing how the others will act but they do know the choice set, the payoffs associated with every outcome, and the preferences of all players. Furthermore, all of this is common knowledge. What makes the game a dilemma is that the unique Nash equilibrium, in which no player can do better by deviating unilaterally, is inefficient. Independently from the other players' choices, it is the dominant strategy for each player to defect even though all players would be better off if they cooperated.

Using the above game as baseline, the theoretical IEA literature models climate change mitigation usually as an n-player dilemma game with multiple stages. In the first stage, all countries choose whether to be a signatory to an IEA or not while the corresponding contributions to the public good are determined in subsequent stages. The essential feature of IEAs is that they must be self-enforcing because sovereign countries cannot be forced to sign an IEA. This feature is incorporated by the concept of internal and external stability. An IEA is internally stable if no signatory wants to leave the agreement unilaterally and it is externally stable if no non-signatory wants to join the

agreement unilaterally. The IEA literature also derives rather pessimistic predictions. If the difference in payoffs between the non-cooperative and full cooperative outcomes is large, only few countries are predicted to form a self-enforcing IEA. Hence, when the potential cooperative efficiency gains are large, a self-enforcing IEA may only marginally improve upon the non-cooperative outcome (e.g. Barrett 1994, Hoel 1992, Carraro and Siniscalco 1993). An IEA may attract more participants by lowering the public good provision required from the signatories. That is, an IEA which does not maximize the collective payoff by fully internalizing mutual benefits of the signatories but only partially internalizes benefits may be acceptable to more countries and thereby generate efficiency gains (Finus and Maus 2008). However, this setting does not allow countries to reach the social optimum.

Differently from the above literature, climate change mitigation has been also modeled as a coordination game (Milinski et al. 2008). In this game players face abrupt and catastrophic climate change if their contributions to the public good fall short of a certain threshold. This game involves multiple equilibria including the full cooperative outcome. The difficulty for the players is, therefore, to coordinate on the efficient outcome rather than to cooperate. This problem is much easier to be solved than the above mentioned dilemma problem, particularly if the players have the opportunity to communicate. However, coordination may still be difficult if players differ in responsibility and wherewithal and for that reason cannot agree on fair burden sharing.

Based on these theoretical considerations, the thesis presents different climate change mitigation games experimentally tested in the lab. Some models are directly tested while others are extended by certain design features. Inspired by real-world climate change negotiations, these added features include different institutions to determine the terms of an IEA, differences between players with respect to responsibility and wherewithal, and a non-binding 'pledge and review' mechanism.

The *second* conceptual dimension of the thesis deals with the question what may drive voluntary contributions to public goods which go beyond the individually rational and selfish level. The underlying theoretical models in this part go beyond the standard assumption of payoff-maximizing actors and allow for 'other-regarding' or social preferences. For example, the models on inequity aversion assume that people suffer from differences between their own payoff and other people's payoff (Fehr and Schmidt 1999, Bolton and Ockenfels 2000). The models on social norms assume that people

suffer from non-compliance with social norms and feel morally obliged to act in a certain way (Levitt and List 2007). The term 'warm glow' describes preferences, where individuals derive positive utility from the mere act of contributing (Andreoni 1990). The phenomenon of conditional cooperation predicts that individuals are more willing to contribute if they know that others contribute (Fischbacher et al. 2001). Although these models have been developed to explain the behavior of individuals, they may also be suited to capture the guiding principles or 'preferences' of countries. Governments form some kind of collective preference to reach a decision. This preference formation is a complex matter influenced by many factors like preferences of voters, delegates, and influential interest groups. It is not possible to describe and explain this complex process. In general, countries can be expected to act more selfishly than individuals. Most experiments find that groups are closer to the standard equilibrium choice than individuals (e.g. Bornstein et al. 2004, Gillet et al. 2009). Furthermore, social consciousness and social norms often occur within families, communities and societies. They are less distinct and, therefore, less likely to guide behavior in international relations. However, it seems reasonable to expect drivers of individual behavior to be guiding also government decisions to some extent.

Based on these theoretical considerations, the thesis presents in this part different experiments which elicit social preferences and study the determinants of private contributions to public goods. The subjects in these experiments are not students but people involved in real-world climate change negotiations and citizens. As for the former – the experiment with climate negotiators – the aim is, on the one hand, to compare the climate negotiators' behavior with student experiments. On the other hand, the experiment aims at investigating whether climate negotiators' preferences differ between regions and whether the differences (if existent) help to explain different positions in international climate policy. As for the latter – the experiment with citizens – the aim is to examine the determinants of private contributions to public goods and to explore insights in the measurement of social preferences by economic experiments. Unlike all other chapters in this thesis, the public good examined in these experiments does not refer to climate change mitigation but to charitable donations. There are several reasons to do so: First, charitable donations, for example to development aid, are well suited to measure the willingness to contribute to a specific public good. In contrast, it is very difficult to elicit the individual willingness to pay for climate protection

because these contributions often take the form of behavior modifications, i.e. opportunity costs, instead of direct payments. Second, people are used to being asked for charitable donations, i.e. the decision about a donation is not new to them. Therefore, they are more likely to have existing and stable preferences which can be elicited in an experiment. Third, the purposes of charitable donations and climate change mitigation often coincide. Poverty reduction, protection of species, and emergency aid after natural disasters may serve as examples. Therefore, the analysis of charitable donations also provides some insights for the willingness to contribute to climate protection.

The two conceptual dimensions of the thesis are inseparably interlinked: Standard economic theory assumes that players' preferences coincide precisely with their own payoff and that players do not cooperate in games where free-riding on others' efforts is possible. The assumption of other-regarding preferences changes the nature of the game. In the extreme case in which all players have a strong positive regard for the well-being of others the free-riding incentives disappear and the problem of non-cooperation does not exist. Any assumption between these two extremes produces a trade-off between the agents' egoistic and the non-egoistic preference components. The consequences of this conflict for the climate change game are not clear and depend on the existence and weight of the preference components. The literature on the economics of international environmental agreements mostly assumes standard, i.e. purely egoistic, preferences. Exceptions include a preference for equity (Lange and Vogt 2003, Lange 2006, Kosfeld et al. 2009). A recent idea suggests that countries get a 'warm-glow' from contributing to solve the problem (Kolstad 2010). Which preference modeling approach is best suited to capture the guiding principles in international relations is ultimately an empirical question. This thesis aims at providing some information and data on these issues.

Methodological approach

In order to conduct the conceptually twofold analysis mentioned above, three different types of experiments are employed. *First*, conventional lab experiments with students constitute the basis of the analysis by providing insights into subjects' behavior when facing a dilemma or coordination problem. They show the consequences arising from real (and possibly other-regarding) preferences for the ability to solve the dilemma or

coordination problem. The general result is that, depending on the problem and the available institutions, the achieved degree of cooperation and coordination does not always correspond to the theoretically predicted level. This suggests that there are forces driving the behavior that are not captured by standard economic theory. But do these forces also guide the behavior of countries? We do not know and probably never will. The nearest we can come to answering that question is to run experiments with governments, delegates, and voters. Therefore, the *second* type of experiments presented in this thesis is an online experiment with delegates involved in climate negotiations. It is one of the very few studies using real-world relevant decision makers as experimental subjects (e.g. Bohm 1997a, 1997b, Bohm and Carlén 1999, Fatas et al. 2007). For many reasons, experiments with real decision makers are particularly hard to carry out but they provide valuable insight into the question if and how the behavior of students and that of decision makers vary. The delegates in this experiment show social preferences similar to those observed in comparable student experiments. However, the results also indicate that these individual preferences for fairness are more pronounced than the expected collective preferences of countries. *Third*, framed field experiments with citizens drawn from a random sample of a German city complete the methodological approach. The behavior of these subjects is also in the range of comparable student experiments. These experiments confirm that it is at least plausible to assume that countries do not only care about their own self-interest but also to some extent about the well-being of other countries.

Two broad branches of experimental literature are related to this thesis. The first branch includes public goods game while the second includes all games designed to elicit and examine other-regarding preferences. In the following, I will give a short overview of both areas.

The *first* branch of experimental literature includes public goods games and all variations of that game. In the last few years, hundreds of public goods experiments have been conducted to better understand the free-rider problem and the institutions which may solve it. These experiments may be classified as first-generation, second-generation, and third-generation (Rockenbach and Wolff 2009). In the first generation of experiments, subjects were exogenously exposed to the experimenter-determined rules. The most prominent rule features examined include punishment opportunities (e.g. Fehr and Gächter 2000), communication (e.g. Brosig et al. 2003), leadership (e.g. Sturm

and Weimann 2008), and reputation opportunities (e.g. Milinski et al. 2006). The general finding in these studies is that in the standard version of the game cooperation starts out being relatively high in the first periods of repeated play but deteriorates thereafter. However, the introduction of certain rule features, such as punishment or communication, can boost cooperation even if they should not have an effect according to the standard theory. The second generation of public goods experiments examines the acceptance of different experimenter-given institutions. The first type of studies analyzes the self-selection of individuals into groups with an exogenously given institution. These experiments demonstrate that individuals voting with their feet between different institutional frameworks can considerably increase efficiency in public goods provision (e.g. Gürerk et al. 2006, Rockenbach and Milinski 2006). The second type considers fixed groups that self-select the institution that shall apply to their interaction. These studies show that endogenously imposed institutions work better than identical, but exogenously imposed institutions (e.g. Tyran and Feld 2006, Sutter et al. 2010). In the third generation of public goods experiments, subjects act as lawmakers empowered to freely shape the institutional environment of the game (e.g. Rockenbach and Wolff 2009). As this generation of experiments is still in its infancy, it is difficult to derive a general conclusion. It seems that there is no clear 'winner' institution, though subjects make extensive use of punishment.

All these public goods experiments provide illuminating insights into the provision of public goods, as well as the development and performance of different institutions. They show that, even though the number of players is limited and disturbing effects outside the game are suppressed in the lab, the mere existence of free-riding possibilities prevent players from reaching the social optimum. At the same time, the experiments show, for example, that punishment is an important facet of human behavior, which potentially secures the provision of many public goods, even if it is not credible from a theoretical viewpoint. Similarly, communication has been shown to work, even if it is 'cheap talk'. However, not all of these findings can be applied to climate change mitigation. For example, most of the first-generation public goods experiments with punishment implement one-way sanctions without counter-punishment opportunities. In real-world negotiations, sanctions can only be implemented if countries voluntarily accept them. Other punishment opportunities, such as trade restrictions or import tariffs, are difficult to implement for many reasons,

including impracticability and legitimacy, and they may provoke retaliatory measures. The second-generation experiments which examine collective rule choices by voting-with-feet or ballot voting do not capture the provision of global public goods because no country can leave the planet and no country can be forced to accept institutional decisions of a majority or even to take part in the negotiations. Similarly, the third-generation experiments cover global public goods only insofar the endogenously developed institutions are in line with customary international law. Summing up, the economics of climate change, the sovereignty of countries, and the customary international law constitute the rules of the game. These basic conditions are fixed at any point in time. Therefore, countries have only a limited number of strategies available including pledges, voluntary contributions, and the formation of coalitions, which are all subject of this thesis. In the long run it may be possible to change the economics of climate change and the nature of the game for example by adaptation and technological progress. But this shall not be discussed in this thesis.

The *second* branch of experimental literature related to this thesis includes studies addressing the question whether social preferences measured in experiments are predictive of behavior in other games or other contexts. There are three different types of studies: First, several lab experiments use context-free games to measure individual social preferences and relate the observed behavior to the performance in another context-free game by means of within-subject tests (e.g. Ashraf et al. 2006, Blanco et al. forthcoming, Brosig et al. 2007). These studies mostly test theories of other-regarding behavior. The experimental results are mixed indicating that individual behavior is not reliably consistent across games. The second type of studies deals with the consequences of context for decision making within economic experiments. These studies aim, for example, at comparing dictator game allocations with charitable donations (e.g. Eckel and Grossman 1996, Bettinger and Slonim 2006, Brañas-Garza 2006). They generally find that people give more to charities than to peers in a dictator game. Other studies in this class compare behavior in context-free social dilemma games with contributions to naturally occurring public goods using within-subject tests (e.g. Laury and Taylor 2008, de Oliveira et al. 2008). The experimental results indicate that cooperative behavior across multiple contexts tends to be stable, albeit the relation is not always incontrovertible. The third type of studies tests whether individual other-

regarding behavior in the lab and in the field correlates (e.g. Benz and Meier 2008, Fehr and Leibbrandt 2008, Carpenter and Myers 2010) which often is the case.

All these experiments confirm that a substantial share of experimental subjects does not act selfishly, but shares their endowment, rewards pro-social behavior, and contributes to public goods. More importantly, they test whether other-regarding preferences are stable across games or contexts. The results are ambiguous indicating the complexity and sensitivity of preferences but also the difficulty to elicit 'true' preferences by simple experimental games. The thesis adds to this literature by analyzing other-regarding preferences of climate negotiators and citizens. These subject pools allow for investigating socio-economic characteristics such as age, education, religion and – in case of the climate negotiators – nationality as potential determinants of other-regarding preferences. Moreover, the thesis contributes to a methodological improvement in the elicitation of preferences by demonstrating the difference between existing and constructed preferences.

Structure of the dissertation

This dissertation comprises a selection of essays on the provision of global public goods and the elicitation of other-regarding preferences with a special focus on climate change mitigation. Each chapter provides a stand-alone analysis featuring an introduction to the research question of interest, the contribution to existing literature and the methodological approach. The majority of essays was written in collaboration with co-authors and simultaneously prepared for submission to academic journals. Against this background, a schematic overview of the thesis (including employed methodology, co-authors, and status of submission) is provided in Table 1.1 subsequent to the introduction. The dissertation is structured along two thematic lines: Following this introduction, *Part I* presents the results of three lab experiments simulating the climate change mitigation problem: Chapter 2 and Chapter 3 analyze a dilemma game and test theory on the formation of coalitions with different institutions. These institutions are compared to a standard voluntary contribution mechanism and institutions that govern not only coalition members but all players. Chapter 4 examines a coordination game in which players face catastrophic climate change damage if their emission abatement falls short of a certain threshold. Players in this game differ with respect to wealth and

responsibility and they have the opportunity to communicate via non-binding pledges. *Part II* examines other-regarding preferences as a motivation to contribute to public goods: Chapter 5 presents the results of an online experiment that elicits the social preferences of climate negotiators. The negotiators' behavior is compared to corresponding student behavior. The experiment, furthermore, focuses on cross-country differences between negotiators. Chapter 6 and Chapter 7 present the results of a framed field experiment with residents of Mannheim, Germany, in which subjects had the opportunity to donate for various charitable purposes. Using a non-student subject pool allows the analysis of socio-economic variables as potential determinants of the willingness to contribute to a public good. Chapter 6 examines how providing potential donors with information about the revenues of a charity affects charitable contributions. It adds to the literature by analyzing the effects of third-party contributions on one's own contribution to a public good. Chapter 7 compares subjects' donation decisions with their behavior in a conventional dictator game and, therewith, adds to the literature examining the stability of preferences across games and contexts. This chapter also provides some methodological insights by suggesting an explanation why experimental subjects often do not behave consistently across games. As the closing section of this thesis, Chapter 8 summarizes its central findings and concludes.

Table 1.1: Schematic overview of the dissertation

Part	Chapter	Method	Co-Authors	Status
I. Climate change mitigation games	The formation of international environmental agreements	Lab experiment	Andreas Lange (University of Hamburg) Bodo Sturm (HTWK Leipzig)	NBER working paper
	Voting in international environmental agreements	Lab experiment	–	Forthcoming in: *Strategic Behavior and the Environment*
	The role of inequality and pledges in a climate change coordination game	Lab experiment	Andreas Löschel (ZEW Mannheim) Alessandro Tavoni (LSE London)	Forthcoming in: *Proceedings of the National Academy of Sciences*
II. Other-regarding preferences	The social preferences of climate negotiators	Online experiment	Bodo Sturm (HTWK Leipzig) Carsten Vogt (HS Bochum)	Published in: *Environmental and Resource Economics*
	The effects of third-party input on voluntary public goods contributions	Framed field experiment	Bodo Aretz (ZEW Mannheim) Sarah Borgloh (ZEW Mannheim)	ZEW working paper
	The construction of social preferences in experiments	Framed field experiment	Bodo Aretz (ZEW Mannheim) Sarah Borgloh (ZEW Mannheim)	ZEW working paper

Part I

Climate change mitigation games

2 The formation of international environmental agreements

2.1 Introduction

The provision of global public goods relies on voluntary contributions and international cooperation. In the absence of enforcement mechanisms to deter countries from free-riding, it is challenging to design institutions that facilitate the provision of public goods while also being voluntarily accepted by the relevant countries. Climate change policy serves as one of the most prominent examples. After decade long negotiations countries still debate the right way to move forward: to have negotiations involving all or many countries, to establish smaller coalitions that formulate their own agreements or just lower the requirements to achieve unanimous decisions. International environmental agreements (IEA), for example, may be ratified by only a subset of countries: While some countries form a coalition to cooperate, others may free-ride on the coalition's efforts. The game theory literature usually models IEAs as an n-country dilemma game with multiple stages. In the first stage, all countries choose whether to be a signatory to an IEA or not. In the second stage, signatories determine their emission abatement levels with the objective of maximizing their collective payoff. In the third stage non-signatories choose their abatement levels independently with the goal of maximizing their individual payoff. If the underlying game involves dominant strategies, the final two stages could also be turned into a single stage because signatories cannot influence the behavior of the non-signatories by choosing a certain action. The essential feature of IEAs is that they must be self-enforcing because sovereign countries cannot be forced to sign an IEA. This feature is incorporated by the concept of internal and external stability. An IEA is internally stable if no signatory would like to leave the agreement unilaterally. It is externally stable, if no non-signatory would like to join the agreement unilaterally.

Forming an IEA thereby involves (at least) two challenges: On the one hand, the institutional arrangement needs to attract members to the coalition (‘extensive margin’). On the other hand, any given coalition should be able to internalize the mutual benefits among its members, i.e. increase the provision of the global public good (‘intensive margin’). In this chapter, the abilities of different institutions to address these two issues are compared. Theory on the formation of coalitions is tested in a laboratory experiment and we compare the resulting provision level of the public good with those achieved by

institutions that do not allow for the formation of subgroups, like a voluntary contribution mechanism.

The experiment is guided by a series of theoretical papers on IEA formation (Barrett 1994, Hoel 1992, Carraro and Siniscalco 1993) that was inspired by theories on cartel formation (d'Aspremont et al. 1983). The IEA literature derives rather pessimistic predictions: As individual countries have a strong incentive to free-ride on the provision of the public goods by others, only a few countries are predicted to form a coalition when the coalition maximizes the mutual benefits of its members. Consequently, no substantial efficiency gains compared to a voluntary contributions mechanism are predicted. Finus and Maus (2008) suggest that a coalition can attract more members by lowering the required public good provision levels. That is, an IEA that only partially internalizes the mutual benefits among its signatories, may be acceptable to more countries and thereby generate efficiency gains. This leads to a trade-off between the extensive and intensive margin, i.e. between the number of signatories and the degree to which they internalize their benefits and provide the global public good. This chapter provides a first experimental test of this literature.

The extent to which different institutions within IEAs are able to generate gains in the provision of global public goods along the intensive and extensive margins has so far not received much attention in the experimental literature. Most experiments involve some form of voting to determine whether a coalition is to be implemented, but do not allow coalition members to negotiate and to agree on a (possibly suboptimal) effort level.

Burger and Kolstad (2009) consider a ten-person linear public goods game with binary choice where subjects must allocate either all or none of their endowment to the public good. They introduce a coalition formation mechanism where subjects start the game by electing to either join the coalition or not. After being informed about the coalition size, all coalition members vote to determine the joint action. If a majority votes to contribute the coalition's entire endowment is allocated to the public good; otherwise the endowment is allocated to private consumption. The coalition cannot subdivide its collective endowment. The experiment demonstrates that the possibility to form a coalition increases the overall provision of the public good. Contrary to theory, the coalition size increases with higher return on the public good.

Kosfeld et al. (2009) use a four-person linear public goods game with three stages. In the first stage, each player decides whether to participate in a costly organization or not. After being informed about the numbers of players willing to participate, each participant decides whether to implement the organization. Using a unanimity rule, the organization is only implemented if all participants agree with the implementation. In the final stage, members of the organization are bound to contribute their full endowment to the public good if the organization has been implemented before and they are free in their choice if the organization has not been implemented before. Non-members are free to choose the amount of their contributions independently from the implementation of the organization. An additional control treatment (presented in the web appendix) allows for non-compliance in the contribution stage: Members are free in their contribution decision, even if the organization has been implemented before, but face an effective punishment if they do not contribute everything to the public good. The experimental results show that the possibility to form a coalition enhances social welfare. However, players are unwilling to form coalitions which govern only a subset of players, even if these rejections are costly. Therefore, most of the implemented coalitions are grand coalitions.

McEvoy et al. (2010) consider a ten-person linear public goods game with a coalition formation mechanism where members have the possibility to violate their contribution commitments. The control treatment with costless enforcement of members' compliance involves only one stage in which each player decides whether to join a coalition or not. Members contribute one indivisible unit to the public good if the coalition size is equal or greater than the theoretically stable size; otherwise they do not contribute. Non-members do not contribute to the public good independent of there being a coalition or not. Two stages are added to the treatments with costly enforcement of compliance. Provided that enough subjects have entered the coalition, coalition members must decide whether to comply with the agreement, i.e. contribute to the public good, or not. Non-compliant members face a sanction (in expected values) in the final stage. Contrary to theory, costly enforcement of compliance leads to lower public good provision than costless enforcement. The frequency of coalition formation and the overall provision of the public good, however, increase if all subjects are required to join a coalition for it to form.

The present experiment is also related to a number of recent studies dealing with the theme of how institutions can improve efficiency in social dilemmas. The first branch of this literature studies the self-selection of individuals into groups with an exogenously given institution. These experiments demonstrate that individuals voting with their feet between different institutional frameworks can considerably increase efficiency in public goods provision (Gürerk et al. 2006, Rockenbach and Milinski 2006).[1] The second branch considers fixed groups that self-select the institution that shall apply to their interaction. These studies show that endogenously determined institutions work better than identical but exogenously determined institutions (Tyran and Feld 2006, Sutter et al. 2010). However, participation in these institutions is not voluntary.

The experiment presented in this chapter tests the ability of three different institutions to attract members. They all involve an initial decision of players to join or abstain from a coalition, i.e. the agreement allows for partial and voluntary participation. The institutions differ in the way public good provision is required from members of the coalition: First, a setting where coalition members are exogenously bound to fully internalize their mutual benefits is considered. This treatment directly tests the IEA literature (e.g. Barrett 1994). The second treatment considers if lowering the institutional requirements from coalition members, e.g. reducing the required public good provision level, can attract more members and thereby lead to efficiency gains (thereby testing Finus and Maus 2008). The third treatment considers an institution in which members can each suggest a minimum public good provision level. The smallest suggested level is then binding for all members. This idea of players agreeing on the smallest common denominator closely follows many real world IEAs. International agreements often codify uniform obligations among countries (Barrett 2003) and, since each participating country needs to sign and ratify the agreement, the player with the smallest proposal is pivotal. Any country can, however, voluntarily go beyond its obligations.

These different institutions on coalition formation are compared with institutions that involve all players: a voluntary contribution mechanism (VCM) and a mechanism in which *all* players are subject to the minimum proposal institution, i.e. participation is

[1] Similar results are provided by experiments that allow the subjects to change the group membership by regrouping, expulsion or other mechanisms (e.g. Page et al. 2005, Cinyabuguma et al. 2005, Brosig et al. 2005, Charness and Yang 2008).

exogenous. Orzen (2008) studies the latter institution in a repeated four-person public good game and finds that it is very effective, often reaching full efficiency in the final period.

All treatments consider a payoff structure that is linear in the total public good provision level, but non-linear in the individual contributions. At the individual level, this reflects increasing marginal provision costs to the public good which may arise from budget constraints, i.e. decreasing marginal utility from numeraire consumption. This specification allows a direct test of the above mentioned IEA literature. The experiment confirms the rather pessimistic conclusions from the theory: Only few players form a coalition and only minor efficiency gains relative to the VCM result when members are required to fully internalize their mutual benefits. Contrary to theory, coalitions that try to reduce the free-riding incentives by requiring less provision from their members, cannot attract additional members. That is, the predicted trade-off between intensive and extensive margin generally fails. However, efficiency gains occur from larger coalition sizes when coalition members can each suggest a minimum contribution level with the smallest common denominator being binding. The experiment thereby shows that the way how terms of an IEA are reached matters for the acceptance of such an agreement. More agents are willing to enter the coalition when they have a possibility to influence the public good provisions requirements in the coalition. The experimental results are thereby in line with findings in the literature that show that endogenizing institutional features improves upon public good provision compared to exogenously implemented institutions. The experiment however shows an advantage of endogenous institutions that has not received much attention so far: They increase the willingness to join if participation is voluntary. However, not all players participate in the coalition. The coalition structure therefore suffers from manifesting inequality between insiders and outsiders and thereby lowers the willingness of signatories to provide the global public good. In contrast, the smallest common denominator structure frequently achieves close to efficient public good provision levels when it involves *all* players.

The results of the experiment have implications for public policy. Forming IEAs to provide global public goods can be beneficial compared to just relying on voluntary contributions from individual countries. However, the terms of institutionalizing the provision requirements from signatories are crucial for the capacity to attract members: Following an exogenous rule that specifies the required contribution levels from

members (full or partial internalization of benefits) is less effective in inducing players to join the coalition than an institution that allows potential cooperators to endogenously determine the rules. If agents are only bound to the smallest common denominator, more players are willing to accept the coalition. While these institutions with partial coverage can thereby generate efficiency gains, it appears worthwhile to explore an institutional setting in which *all* agents participate in making minimum proposals.[2]

The remainder of this chapter is structured as follows: Section 2.2 provides a short theory of coalition formation and public goods provision which generates the predictions for the experiment. The experimental design is reported in Section 2.3, before results are presented in Section 2.4. Section 2.5 finally concludes.

2.2 Theoretical background

A world is considered with $i = 1,...,n$ identical players (countries) with utility functions of the form

$$u_i = y_i + \gamma Q \qquad (2.1)$$

where y_i is a numeraire, $Q = \sum_{j=1}^{n} q_j$ represents the total provision level of the global public good and γ denotes the (constant) marginal utility from the public good. Players can allocate their initial income w to consumption or global public good provision q_i with the budget constraint given by

$$y_i + q_i^2 \leq w \qquad (2.2)$$

The payoff structure given by (2.1) and (2.2) is used to derive analytic predictions for the experiment.[3] Throughout this chapter, interior solutions which requires $w \geq n\gamma/2$ are assumed.

[2] The institution could formally be made incentive-compatible by requiring players to deposit a bond covering the level of their own minimum proposal. When the smallest common denominator is determined the difference between this bond and the binding minimum can be returned. Agents have an incentive to carry out their obligations in order to regain their deposit. For a possible implementation of such a deposit mechanism, see Gerber and Wichard (2009).

[3] This specification deviates from a large part of the literature on voluntary public good provision which largely considers linear provision costs and implies a dominant strategy of giving zero in the Nash equilibrium such that any variance in the data could mistakenly be interpreted as altruism (Ledyard 1995).

2.2.1 Voluntary contribution mechanism and social optimum

Individual utility maximization immediately yields the individual Nash provision level $q_i^{NE} = \gamma/2$ with the total contributions given by $Q^{NE} = n\gamma/2$. It should be noted that the Nash equilibrium involves a dominant strategy such that each player's actions do not depend on the provision levels chosen by the remaining players. The social optimum maximizes total payoff and is given by $q_i^{SO} = n\gamma/2$ ($q_i^{SO} = \max_q n\left[-q^2 + \gamma nq\right]$) and $Q^{SO} = n^2\,\gamma/2$.

The IEA institutions all involve two stages. In the first stage, each player decides about participation in the coalition. The set of players who are members of the coalition is denoted by S with k ($1 \le k \le n$) being its size. In the second stage, the global public good is provided. Non-members are free to choose their public good provision level. Due to the assumed linearity of the public good, their payoff-maximizing decision does not depend on the coalition efforts and is again given by $q_i^{NC} = \gamma/2$. For the choice of public good provision by the k signatories to the IEA in this second stage, different institutions are compared.

2.2.2 Payoff maximizing coalition

If members of the coalition fully internalize their mutual benefits, the payoff-maximizing individual provision level given coalition size k is $q_i^C(k) = \gamma k/2$ ($q_i^C(k) = \max_q \left[-q^2 + \gamma kq\right]$) for all members of the coalition. This treatment is denoted by *'COALfull'*.

2.2.3 Partial internalization of benefits inside the coalition

This setting assumes that members of the coalition are not able to fully internalize their mutual benefits, but only internalize at a ratio of $\alpha \le 1$. That is, the provision level given coalition size k is $q_i^C(k,\alpha) = \alpha\gamma k/2$ for all members of the coalition. This

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Differently, the non-linear structure used here generates positive Nash contributions. It corresponds to the utility function that has been used in a large part of the IEA literature (e.g. Carraro and Siniscalco 1993, Barrett 1994)

institution has been suggested by Finus and Maus (2008) and is denoted by *'COALpartial'*.

2.2.4 Smallest common denominator inside the coalition

This setting finally considers an institution for negotiations inside the coalition that splits the second stage into to steps: First, members of the coalition are requested to suggest a minimum public good provision level. Second, after these minimum proposals $q_i^{\min}$ are received from all participating parties, the agreement will require all signatories to provide at least the smallest suggested level $\min_{j\in S} q_j^{\min}$. That is, signatories are bound to provide $q_i \geq q^{\min} = \min_{j\in S} q_j^{\min}$. This institution is denoted by *'COALmin'*.

When limited to provide $q_i \geq q^{\min} = \min_{j\in S} q_j^{\min}$, the individually payoff-maximizing provision level at this last stage is clearly given by $q_i = \max\left[q^{\min}, \gamma/2\right]$ as no player has an incentive to provide more than is required if $q^{\min}$ exceeds the individual's payoff-maximizing level. When making their minimum proposal $q_i^{\min}$, the signatories therefore need to recognize their potential impact on the provision levels of all k members of the coalition. Note that this implies that a player should suggest a minimum provision level of $q_i^{\min} = k\gamma/2$ if all other players in the coalition suggest $q_j^{\min} \geq k\gamma/2$ as suggesting a smaller level would lower the binding minimum and hence negatively affect profits. With the same logic, a player should not propose a minimum below $\min_{j\in S, j\neq i} q_j^{\min}$ if some other player suggests $q_j^{\min} < k\gamma/2$. It follows that it is a weakly dominant strategy for a player to suggest $q_i^{\min} = k\gamma/2$. However, there are other equilibria in weakly dominated strategies: Any binding minimum $q^{\min} < k\gamma/2$ is established as equilibrium if at least two players suggest that level while other players suggest a larger minimum.

In summary, if players inside the coalition are requested to suggest a minimum provision level and negotiations implement the smallest minimum level as a binding provision level, the collective optimum is obtained in weakly dominant strategies. Any

other provision level $q \in [\gamma/2, k\gamma/2]$ for each player can be sustained as a subgame perfect Nash equilibrium. This logic immediately implies that the equilibrium in the minimum stage inside coalition coincides with the full internalization (*COALfull*) if all agents play weakly dominant strategies. Furthermore, it implies that the social optimum can be reached in weakly dominant strategies if *all* players participate in the minimum stage. This prediction will be explicitly tested in the experiment by combining a voluntary contribution mechanism with the minimum stage in one treatment ('*VCMmin'*).

In general, however, players may not be able to coordinate on their collective optimum and may implement other equilibria instead. For any given coalition, those would correspond to only a partial internalization of mutual benefits and therefore would endogenously determine some internalization factor $\alpha \leq 1$ as discussed in *COALpartial*.

2.2.5 Membership game

Let us now turn to the decisions of players in the first stage, i.e. the choice joining the coalition or not. All the second stage institutions for deciding the provision level inside the coalition lead to specific incentives of players to join the coalition. Consequently, different coalition sizes may result. The results are discussed in turn.

In general, the payoff to members of the coalition given a coalition size of k and institution I shall be denoted by $\Pi^C(k, I)$, the payoff to non-members shall be denoted by $\Pi^{NC}(k, I)$. Using the terminology from the IEA literature (Barrett 1994, Carraro and Siniscalco 1993), a coalition of size k is externally stable if no non-member has an incentive to join unilaterally, i.e. if $\Pi^{NC}(k, I) > \Pi^C(k+1, I)$.[4] The coalition of size k is internally stable if no member has an incentive to leave unilaterally, i.e. if $\Pi^C(k, I) \geq \Pi^{NC}(k-1, I)$.

For the institutions *COALfull* and *COALpartial* the following result can be derived: A coalition that is internally and externally stable satisfies

[4] It is assumed that a player would join the coalition if he or she is indifferent as this increases payoffs to all other agents.

$k \leq \frac{2+\sqrt{3-2\alpha}}{\alpha}$ and $k+1 > \frac{2+\sqrt{3-2\alpha}}{\alpha}$.

The proof involves a straightforward comparison of payoffs which follow from (2.1) and (2.2) with

$$\Pi^C(k,\alpha) = [-(\alpha k\gamma/2)^2 + \gamma[\alpha k^2\gamma/2 + (n-k)\gamma/2]$$

and

$$\Pi^{NC}(k-1,\alpha) = -(\gamma/2)^2 + \gamma[\alpha(k-1)^2\gamma/2 + (n-k+1)\gamma/2].$$

For the standard coalition game (*COALfull*) in which the coalition fully internalizes their mutual benefits ($\alpha = 1$), this implies that only 3 players form the coalition ($k = 3$). Figure 2.1 shows how the predicted size of stable coalitions depends on α. The decreasing relation corresponds to a trade-off between intensive and extensive margins: For example, coalitions of $k = 6$ players could be stabilized for $\alpha = 0.5$ while only 3 players form a coalition when mutual benefits are fully internalized. The increased coalition size can thereby also generate efficiency gains, i.e. increases in total payoff to all agents and in the payoff to the average coalition member. The example of $k = 6$ and $\alpha = 0.5$ illustrates this result: Compared to the $k = 3$ solution when $\alpha = 1$, the same total provision level results while the provision efforts are being distributed across more players. Due to the increasing marginal provision costs, gains in total payoffs result.

Let us now consider the institution in which members can make their minimum suggestion (*COALmin*). Since the weakly dominant strategy in the subgame following the membership decision involves full internalization of mutual benefits, the only subgame perfect equilibrium in weakly dominant strategies equals the $k = 3$ result in *COALfull*. However, other equilibria exist in the minimum stage that lead to less than full internalization ($q \in [\gamma/2, k\gamma/2]$. As a result, potentially larger coalition sizes could be stabilized. To see this, the incentive of a player to leave a coalition is considered. The equilibrium contribution levels that result in a coalition S is denoted by $q(S) \in [\gamma/2, k\gamma/2]$. The payoff to a player i inside coalition S of size k is given by

$$\Pi^C(S, COALmin) = -q(S)^2 + \gamma[kq(S) + (n-k)q^{NC}]$$

and compares to a payoff when leaving the coalition of

$\Pi^{NC}(S \setminus \{i\}, COALmin) = -(q^{NC})^2 + \gamma[(k-1)q(S \setminus \{i\}) + (n-k+1)q^{NC}]$.

The payoff to members of the coalition is increasing in $q(S) \in [\gamma/2, k\gamma/2]$, while the payoff to player i when leaving the coalition is increasing in $q(S \setminus \{i\})$. That is, the incentive to leave a coalition depends how much free-riding will be punished by the remaining members through a reduction of $q(S \setminus \{i\})$. The multiplicity of equilibria in the contribution stage hereby allows stabilizing any coalition size. For example, the grand coalition is stabilized when players choose the following subgame-perfect strategies: (i) all agents coordinate on the full internalization in the grand coalition, while (ii) in all smaller coalitions players suggest the minimum contribution at the Nash level ($q^{\min} = \gamma/2$).[5]

To sum up, in the coalition game in which negotiating parties agree to implement provision obligations at the smallest minimum level suggested by a member of the coalition, the social optimum in a grand coalition (as well as any other coalition size) can be stabilized in a subgame perfect equilibrium. The only equilibrium in weakly dominant strategies corresponds to the coalition game in which three members fully internalize their mutual benefits. While not allowing precise predictions, the multiplicity of equilibria in this minimum proposal game gives one reason to explicitly test the behavior of players in an experimental setting. The next sections therefore turn to an experimental test of the institutions described above, in particular comparing institutions that exogenously fix the internalization inside coalitions (*COALfull* and *COALpartial*) with the endogenously determined institutional requirements in *COALmin*.

2.3 Experimental design

The experiment was designed to test the different institutions on coalition formation within a ten-person public good setting. The payoff function for each player was given by $\pi_i = -q_i^2 + \gamma Q = -q_i^2 + \gamma \sum_{j=1}^{n} q_j$ with $\gamma = 10$, $n = 10$ and $q_i \in [0,...,100]$ and was common knowledge. We begin with the traditional '*VCM*' as a control treatment. Three coalition formation treatments introduced a first 'coalition stage' in which subjects

[5] Coalitions that do not include all players may complicate coordination. This could for example be caused by inequality concerns (e.g., Fehr and Schmidt 1999, Lange and Vogt 2003).

needed to decide on participating in the institution. Decisions to join a coalition were made simultaneously and independently. Following this coalition stage, subjects played their contribution game. In treatment *COALfull*, the members' contributions to the public good were exogenously fixed at the level that fully internalized their respective mutual benefits onto each other, while in treatment *COALpartial* they only internalized 50% of their mutual benefits, i.e. $\alpha = 0.5$. Non-members in both treatments were free to set their contributions at any level. Treatment *COALmin* introduced an intermediate stage: After being told the number of subjects in the coalition, all members of the coalition negotiate about the minimum contribution that each member should contribute to the public good (minimum stage). Negotiations take the form that all participants simultaneously and independently proposed a minimum amount between 0 and 100. The smallest proposed amount then became the binding lower limit for the contributions of all coalition members. Members were informed about *all* proposed minimum amounts (arranged in descending order). Non-members did not make any decision in this stage and were only informed about the coalition size. In the contribution stage, members and non-members chose the amount of their contributions to the public good. While non-members could freely choose their contributions, members' contributions were bound to provide at least the binding minimum. Finally, we implemented a treatment *VCMmin* in which *all* subjects took part in the negotiation about a minimum contribution. Players first simultaneously and independently proposed a minimum amount between 0 and 100. The smallest proposed amount then became the binding lower limit for the contributions of all players. Players were informed about all proposed minimum amounts (arranged in descending order). In the contribution stage, all players simultaneously and independently determined the amount of their contribution to the public good which had to be equal or greater than the binding minimum. Table 2.1 summarizes the key features of the experimental design and the number of participants in each session.

The experiment was run in May and July 2009 at the MaxLab laboratory at the University of Magdeburg, Germany. In total, 500 students participated in the experiment, whereby 100 subjects took part in each treatment. No subject participated in more than one treatment. Sessions lasted between 60 and 90 minutes. Twenty subjects were recruited for each session. Each subject was seated at linked computer terminals that were used to transmit all decision and payoff information. The Z-tree

software (Fischbacher 2007) was used for programming and ORSEE (Greiner 2004) for recruiting. Once the individuals were seated and logged into the terminals, a set of instructions and a record sheet were handed out. Experimental instructions included several numerical examples and control questions in order to ensure that all subjects understood the games. The sessions each consisted of 12 rounds, the first two being practice. The subjects were instructed that the practice rounds would not affect earnings. At the beginning of the experiment subjects were randomly assigned to groups of ten. The subjects were not aware of whom they were grouped with, but they did know that they remained within the same group of players throughout the rounds (partner matching). At the end of the experiment, one of non-practice rounds was chosen at random as the round that would determine earnings with an exchange rate between Euro and token of 1:100. On average, a subject earned €10.68 in the games which is slightly above the average hourly wage for student jobs. Additionally, all subjects received €1.00 as show-up fee.[6]

2.4 Experimental results

This section tests the theoretical predictions regarding public good contribution levels across the different institutions.

2.4.1 Contribution and payoff levels

The results summary is crafted by both pooling the data across all periods and reporting treatment differences in the first five and last five periods. The effects of time on contribution schedules are later explored in more detail. Table 2.2 provides mean contribution and payoff levels for each treatment and Figure 2.2 provides a graphical depiction of the data. The left panel presents the average contribution levels across treatments and the right panel reports the resulting average payoff levels. As can be seen from the table and figures, contribution levels in the standard coalition game *COALfull* do not exceed those in the *VCM* (12.1 vs. 12.3 tokens). Average contributions in the *COALpartial* treatment are smaller (8.5 tokens) such that the hypothesized efficiency

[6] Overall, 9 out of 500 subjects earned negative payoffs in the games. In these cases, payoffs were cut off at zero and the subjects only received the show-up fee.

gains do not materialize. Combining the coalition formation framework or the VCM with a minimum stage, however, increases average contributions (14.8 and 22.1 tokens).

These differences are confirmed by a series of Mann-Whitney tests with the average contribution or payoff by one group across all periods being taken as the unit of observation: *VCM* gives larger contributions than *COALpartial* (1% significance), less than the *COALmin* (10% significance), and less than *VCMmin* (10% significance). The standard coalition model *COALfull* gives lower contributions than *COALmin* and *VCMmin* (5% and 10% significance, respectively). Similar comparisons follow for the average payoff, i.e. the efficiency level of the respective institutions (see also Table 2.2): *VCM* performs better than *COALpartial* (1% significance) and worse than *COALmin*, and *VCMmin* (5% and 10% significance respectively). *COALpartial* performs worse than all other institutions (1% significance each) and *COALfull* performs worse than *VCMmin* (10% significance).

In summary, average contribution and payoff levels in the coalition formation game do not exceed those in the VCM if the coalition fully internalizes mutual benefits. If the coalition partially internalizes the mutual benefits, average contributions and payoffs are even lower than those in the VCM. If negotiations among coalition members are facilitated through a smallest common denominator rule, average contributions to the public good increase. The smallest common denominator rule best facilitates public good provision when involving all agents. Further evidence for these findings can be found through a series of linear regression models as illustrated in Tables 2.3 and 2.4. Averaged across all periods, the minimum institutions (*VCMmin* and *COALmin*) perform significantly better than the *VCM* (1% significance), while the partial internalization in the coalition formation structure leads to lower contributions (1% significance).

Figure 2.3 indicates that the contributions in the *VCM* are decreasing over time, they are smaller in the last 5 periods than in the initial 5 periods (see also Table 2.2). This downward trend which has been observed in many other experimental settings primarily for linear public goods is less pronounced for the treatments with coalition structure. In *VCMmin*, contributions increase over time. This effect is due an increase in the proposed minimum contribution levels. As suggested by the theory, some (but not all) groups are able to coordinate on the optimal contribution level (see Figure 2.4).

Furthermore, when concentrating on the last five periods, the coalition structure *COALfull* performs better than the *VCM*. A Mann-Whitney test confirms that *COALfull* leads to larger contributions than *VCM* in the last five periods (10% significance). This suggests that predictions from the theory hold: The coalition formation structure which fully internalizes all the coalition members' benefits provides small benefits compared to the voluntary contribution mechanism. However, the partial internalization of benefits in *COALpartial* does not provide any positive effect. The same comparisons result for the payoff levels. These findings are confirmed by the regression results depicted in Tables 2.3 and 2.4.

2.4.2 Coalition size and internalization of benefits

In the following, the number of agents who join the coalition is considered. Figures 2.5 and 2.8 indicate the crucial differences between the coalition treatments. While the coalition in the standard coalition formation treatment (*COALfull*) include on average close to the predicted three members (3.50), this number is even slightly less in *COALpartial* (3.22). Formulating less strict provision levels in the coalition therefore does not reduce free-riding incentives in a way that more agents join. This result directly puts into question the empirical relevance of the theoretical result by Finus and Maus (2008). A reduced requirement along the intensive margin therefore does not trigger the predicted gains along the extensive margin. The average coalition size increases, however, when agents are allowed to make their own proposals for the minimum provision in the coalition: In *COALmin* the average coalition size is 5.07 which is significantly larger than the one for the other two treatments (Mann Whitney, 1% significance; further evidence in Table 2.5). In summary, the number of agents in the coalition is close to the theoretical prediction in the standard coalition formation game. An exogenous reduction in the provision levels required when joining the coalition does not enlarge the coalition. An institution in which coalition members can suggest their own minimum with the smallest suggested level being binding triggers the entry of more agents.

These observations potentially provide an interesting feature of the acceptance of institutional requirements. In the *COALmin* treatment, agents can impact the coalitions' provision efforts *after* observing the number of coalition members, i.e. the number of

potential cooperators. This implies that they are not bound to a specific provision level just by showing their intent to join the coalition.[7] As a consequence, the 'costs' of joining are smaller such that we should expect more agents to join. This observation is consistent with recent findings in the literature that endogenously determined institutions are better accepted than exogenous rules (Sutter et al. 2010, Tyran and Feld 2006). The important question is, however, what level such coalition can agree upon.

A sensible measure to assess the provision level in the coalition is the internalization ratio, i.e. the ratio of chosen provision effort of the coalition compared with the level that fully internalizes the mutual benefits of coalition members ($\sum_{i \in S} q_i /(k^2 \gamma / 2)$). On average the ratio is given by 83% for the *COALmin* treatment and thereby lies in between levels in *COALfull* and *COALpartial* as illustrated in Figure 2.6.[8] The internalization ratio does depend, however, on the size of the coalition. The internalization ratio is depicted in Figure 2.7 for the different coalition sizes in *COALmin*. Figure 2.7 shows that the ratio based on the average suggested minimum, the binding minimum, as well as the eventually chosen level are decreasing in the coalition size k. This is confirmed by a linear regression model as reported in Table 2.6.

Hence, we observe a trade-off between intensive and extensive margin for the endogenously formed coalition. We can furthermore compare the internalization ratio given by the binding minimum with the ratio needed to stabilize a given coalition size as derived in Section 2.2 (dashed line in Figure 2.7, see also Figure 2.1). Interestingly and surprisingly, the binding minimum ratio (int_min) follows closely the levels that are necessary to stabilize coalitions of the respective size. In particular, the internalization ratios for coalitions that comprise more than 3 players are smaller than 1 (t-test, 1% significance). That is, the coalitions do not fully internalize the benefits of their members. We can only speculate about the reasons: On the one hand, if agents are inequality-averse, they may want to avoid unfavorable payoff differences to free-riders and therefore suggest a lower minimum. On the other hand, it may be more complicated

[7] For example, this can be relevant if players are inequality-averse and want to avoid large payoff inequalities between free-riders and coalition members (see e.g. Fehr and Schmidt 1999).
[8] Note that the internalization ratio is exogenously fixed at 1 in *COALfull* and 0.5 in *COALpartial*.

for larger coalitions to coordinate onto the optimal provision level as they are more susceptible to single players suggesting a small binding minimum.[9]

2.4.3 Decision to enter the coalition

We now have a closer look at the determinants of individual decisions to enter a coalition. One of the most important theoretical results is that the incentives to leave the coalition are the larger, the larger the coalition size is. Table 2.5 shows the average marginal effects from a probit estimation model which explains the decision to join the coalition by the individual's decision in the previous period as well as by the lagged coalition size. The estimation results show that the individual's decision is largely driven by his or her behavior in the previous period (the probability to join the coalition in period *t* is about 43% higher for a coalition member in *t*–1 than for a non-member in *t*–1, 1% significance) which suggests that the decision to enter is relatively stable. In fact, the likelihood of joining the coalition is not significantly influenced by the coalition size in the previous period. For players in *COALmin*, who show an 8% higher probability to join the coalition (1% significance), the internalization ratio based on the binding minimum is also decisive: The larger this internalization ratio in the past period, the smaller is the likelihood of an agent joining the coalition (5% significance).

The coalition formation structure allows people to select into the coalition. One may wonder how these coalition members would have contributed in a VCM. Even though our between-subject design does not allow to generate the right counterfactual, intuition suggests that these players may belong to the group of (conditional) cooperators who also may have had high contributions in public goods games. To shed some light on this idea, subjects in the *VCM* treatment are classified as cooperators if they contribute more than the median value in a given period and non-cooperators otherwise. Comparing the average contributions over all periods, there are no significant differences between cooperators in *VCM* (21 tokens) and coalition members in *COALmin* (21 tokens) or between non-cooperators (6 tokens) and non-members (7 tokens). However, the

[9] This is similar to the effects in *VCMmin* where only some groups are able to coordinate (see Figure 2.4) while others do not achieve larger provision levels as some players consistently make suboptimal minimum suggestions, i.e. do not play the weakly dominant strategy. The difficulties of large groups to coordinate to an efficient outcome have been also observed in the minimum-effort coordination game (Weber 2006).

advantages of the coalition structure develop over time. Averaging over the last five periods, the coalition members' contributions (19 tokens) are higher than the cooperators' contributions (15 tokens) (10% significance). This supports the self-sorting hypothesis and indicates that the coalition structure helps to sustain a relatively high contribution level among the cooperative players.

2.4.4 Decision on minimum levels

The results so far have shown the benefits of institutions that allow agents to first submit a minimum suggestion, before the smallest one will be binding for all agents. In the *VCMmin* treatment this allows agents to step by step coordinate to larger provision levels of the public good. In the *COALmin* treatment this allows agents to condition the coalition efforts on the information on how many agents stay outside the coalition. The implied reduction in the 'risk' of being exploited by free-riders when joining the coalition allows larger coalitions to build which generate larger provision levels of the public good.

A distinct prediction from the theory is that agents in both minimum treatments have a weakly dominant strategy to suggest the minimum which fully internalize the mutual benefits. We have already seen that this full internalization does not occur in the experiment. So how do agents' minimum suggestions evolve over time? Theory would predict that agents' minimum suggestions should move upward: Those who propose a larger level than others have no effect on the binding level. By adjusting downwards, they only can bring down the binding minimum which would hurt their and other players' payoffs. Those who suggested the binding level would have incentives to increase their suggestion since this can only benefit them and others. To test these adjustments over time, a variable 'change_qimin' is defined which reflects the difference between a player's minimum suggestion in the current and in the previous period. Table 2.7 presents the results from a linear regression model. The explanatory variables are the individuals' minimum suggestion in the previous period, the previously binding minimum, and a dummy variably which takes the value one if and only if the agent was a pivotal player in the previous period, i.e. if his or her minimum suggestion was binding. For both treatments, agents adjust their proposals upwards (constant is positive, 1% significance). This adjustment is smaller for subjects who

already have submitted larger proposals in the previous periods. In the *COALmin* treatment we see that in particular pivotal players adjust their proposal upwards. This effect is particularly important since agents' provision levels of the public good are (as predicted) highly sensitive to the required minimum. In fact, 40% of contribution decisions in *VCMmin* and 65% of decisions in *COALmin* are exactly at the binding minimum level. It is therefore evident that those players whose suggestion forms the binding minimum have a large effect on the total provision level of the public good.

2.5 Conclusions

Forming institutions to secure the provision of global public goods is a complicated endeavor. The success of an institution to overcome free-riding incentives depends on two interlinked challenges: On the one hand, the institutional arrangements need to attract signatories, i.e. coalition members (extensive margin). On the other hand, any given coalition should be able to internalize the mutual benefits from the public good among its members (intensive margin).

In this chapter, different institutions were tested with respect to their ability to succeed along these two dimensions. The experimental results show, one the one hand, that institutions that exogenously force members to fully internalize their mutual benefits generate a rather low participation rate, just as theoretically predicted. The resulting provision levels of the global public good do hardly go beyond the ones achieved by a purely voluntary contribution mechanism. On the other hand, lowering the degree of internalization of benefits within the coalition does not attract more members and, accordingly, does not generate efficiency gains.

Benefits arise, however, from institutions that allow members to *endogenously* determine the terms of the agreement as they attract more members. The experiment thereby adds to the recent literature on beneficial endogenous choices of rules in social dilemma situations (e.g. Sutter et al. 2010, Tyran and Feld 2006). In particular, it shows the success of a very simple negotiation rule: Each coalition member can suggest a provision level, knowing that the smallest suggested level is binding for all coalition members. This rule generates larger coalition sizes and larger average contributions while lowering the degree of benefits internalization among members. Efficiency gains therefore result along the extensive margin. There is a clear tradeoff between extensive

and intensive margin: The larger the (endogenously determined) requirements from coalition members were in the previous period, the less willing subjects are to enter the coalition, i.e. the negotiations.

The principle of the smallest common denominator reflects many real-world IEAs which often implement uniform obligations. Coordination on large provision levels, however, does not always happen and also requires time: The largest benefits from coordinating on larger minimum proposals relative to the standard voluntary contribution mechanism occur in the last periods of the experiment. This may suggest that over time coordination may also result in international climate negotiations. However, the coordination on a uniform binding minimum may be more aggravated in such applications as countries are heterogeneous with respect to wealth and responsibility (see Chapter 3). The experimental investigation of the impact of such heterogeneities on coalition formation and on the performance of the different institutions and their possible adjustments are fruitful areas of further research.

2.6 Appendix

2.6.1 Tables

Table 2.1: Summary of experimental design

Treatment	Stages	Coalition structure	n	γ	α	No. of subjects
VCM	contribution	no	10	10		100
COALfull	membership contribution	yes	10	10	1	100
COALpartial	membership contribution	yes	10	10	0.5	100
COALmin	membership minimum contribution	yes	10	10	endogenous	100
VCMmin	minimum contribution	no	10	10		100

Table 2.2: Summary statistics for all treatments

Treatment	q	π	k	*eff*
		Total		
VCM	12.3	905.2		0.21
COALfull	12.1	959.3	3.5	0.24
COALpartial	8.5	727.1	3.2	0.12
COALmin	14.8	1060.1	5.1	0.29
VCMmin	22.1	1418.6		0.47
		First 5 periods		
VCM	15.7	1098.4		0.31
COALfull	13.3	1030.1	3.7	0.27
COALpartial	9.0	766.1	3.1	0.14
COALmin	16.3	1160.1	5.3	0.34
VCMmin	16.8	1187.9		0.35
		Last 5 periods		
VCM	8.9	711.9		0.12
COALfull	10.9	888.5	3.2	0.20
COALpartial	7.9	688.1	3.3	0.11
COALmin	13.4	960.1	4.8	0.24
VCMmin	27.5	1649.2		0.58

Note: q = average contributions, π = average payoffs, k = average coalition size, eff = average efficiency defined as $(\pi - \pi^{NE})/(\pi^{SO} - \pi^{NE})$ with π^{NE} =475 and π^{SO} =2500

Table 2.3: Linear regression of public good contributions for all treatments

VARIABLES	All per. qi	All per. qi	Last 5 per. qi
COALfull	-0.202	-2.420*	2.016*
	(0.957)	(1.340)	(1.029)
COALpartial	-3.826***	-6.702***	-0.950
	(0.726)	(1.070)	(0.702)
COALmin	2.551**	0.582	4.520***
	(1.010)	(1.498)	(1.368)
VCMmin	9.833***	1.046	18.62***
	(3.259)	(2.895)	(4.481)
per6_10		-6.880***	
		(0.999)	
per6_10_COALfull		4.436***	
		(1.427)	
per6_10_COALpartial		5.752***	
		(1.080)	
per6_10_COALmin		3.938*	
		(2.037)	
per6_10_VCMmin		17.57***	
		(3.796)	
Constant	12.30***	15.74***	8.858***
	(0.614)	(0.950)	(0.593)
Observations	5000	5000	2500
R-squared	0.111	0.158	0.252

Note: Random effects estimation; robust standard errors in parentheses (clustered at group level); significance *** p<0.01, ** p<0.05, * p<0.1.
Definition of variables:
qi = subject's contribution,
COALfull = 1 if subject played in the *COALfull* treatment, 0 otherwise,
COALpartial = 1 if subject played in the *COALpartial* treatment, 0 otherwise,
COALmin = 1 if subject played in the *COALmin* treatment, 0 otherwise,
VCMmin = 1 if subject played in the *VCMmin* treatment, 0 otherwise,
per6_10 = 1 for the last five periods, 0 for the first five periods,
per6_10_*treatment* = interaction term of time dummy and treatment dummy.

Table 2.4: Linear regression of payoff levels for all treatments

VARIABLES	All per. pay	All per. pay	Last 5 per. pay
COALfull	54.16	-68.28	176.6**
	(67.48)	(83.56)	(70.25)
COALpartial	-178.1***	-332.3***	-23.77
	(51.47)	(59.07)	(50.91)
COALmin	154.9***	61.70	248.2***
	(58.80)	(73.40)	(82.01)
VCMmin	513.4***	89.52	937.3***
	(165.4)	(156.4)	(217.2)
per6_10		-386.5***	
		(30.73)	
per6_10_COALfull		244.9***	
		(74.87)	
per6_10_COALpartial		308.6***	
		(39.44)	
per6_10_COALmin		186.5*	
		(101.9)	
per6_10_VCMmin		847.8***	
		(183.8)	
Constant	905.2***	1098***	711.9***
	(42.59)	(48.17)	(42.22)
Observations	5000	5000	2500
R-squared	0.083	0.117	0.185

Notes: Random effects estimation; robust standard errors in parentheses (clustered at group level); significance *** p<0.01, ** p<0.05, * p<0.1.
Definition of variables:
pay = subject's payoff level,
COALfull = 1 if subject played in the *COALfull* treatment, 0 otherwise,
COALpartial = 1 if subject played in the *COALpartial* treatment, 0 otherwise,
COALmin = 1 if subject played in the *COALmin* treatment, 0 otherwise,
VCMmin = 1 if subject played in the *VCMmin* treatment, 0 otherwise,
per6_10 = 1 for the last five periods, 0 for the first five periods,
per6_10_*treatment* = interaction term of time dummy and treatment dummy.

Table 2.5: Probit estimation of decision to join the coalition

VARIABLES	All Coal ci	*COALmin* ci
ci_lag	0.429***	0.507***
	(0.019)	(0.031)
k_lag	0.008	-0.005
	(0.007)	(0.009)
meanqi_lag	-0.002	
	(0.002)	
COALpartial	-0.012	
	(0.022)	
COALmin	0.078***	
	(0.023)	
int_ratio_min_lag		-0.074**
		(0.032)
Observations	2700	900

Notes: Average marginal effects; standard errors in parentheses;
significance: *** p<0.01, ** p<0.05, * p<0.1.
Definition of variables:
ci = 1 if subject joined the coalition, 0 otherwise,
ci_lag = 1 if subject joined the coalition in the previous period, 0 otherwise,
k_lag = coalition size in the previous period,
meanqi_lag = mean group contribution in the previous period,
COALpartial = 1 if subject played in the *COALpartial* treatment, 0 otherwise,
COALmin = 1 if subject played in the *COALmin* treatment, 0 otherwise,
int_ratio_min_lag = previous period internalization ratio based on the binding minimum.

Table 2.6: Linear regression of internalization ratios

	COALmin
VARIABLES	int_ratio_min
k	-0.0725***
	(0.0206)
period	-0.0166
	(0.0209)
Constant	1.115***
	(0.213)
Observations	1000
R-squared	0.063

Notes: Regression of internalization ratios for *COALmin*; random effects estimation; robust standard errors in parentheses (clustered at group level);
significance *** p<0.01, ** p<0.05, * p<0.1.
Definition of variables:
int_ratio_min = internalization ratio based on the binding minimum,
k = coalition size,
period = period.

Table 2.7: Linear regression of the adjustment in the individual minimum proposal

	COALmin	*VCMmin*
VARIABLES	change_qimin	change_qimin
qi_min_lag	-0.349***	-0.363***
	(0.0625)	(0.0283)
q_min_lag	-0.236**	0.0118
	(0.0949)	(0.0317)
pivot_lag	5.174*	-0.477
	(2.785)	(1.515)
Constant	15.86***	18.28***
	(2.915)	(1.405)
Observations	344	900
R-squared	0.237	0.201

Notes: Regression of the adjustment in the individual minimum proposal $q_i^{\min}$ over time ($q_i^{\min}$ in current period minus $q_i^{\min}$ in previous period) for *COALmin* and *VCMmin*; standard errors in parentheses; significance *** p<0.01, ** p<0.05, * p<0.1.
Definition of variables:
change_qimin = subject's minimum proposal minus proposal in the previous period,
qi_min_lag = subject's minimum proposal in the previous period,
q_min_lag = binding minimum in the previous period,
pivot_lag = 1 if subject suggested binding minimum in the previous period, 0 otherwise.

2.6.2 Figures

Figure 2.1: Internalization factor needed to stabilize a given coalition size

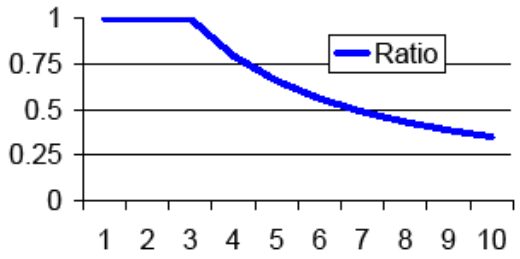


Figure 2.2: Average contribution and payoff levels for all treatments

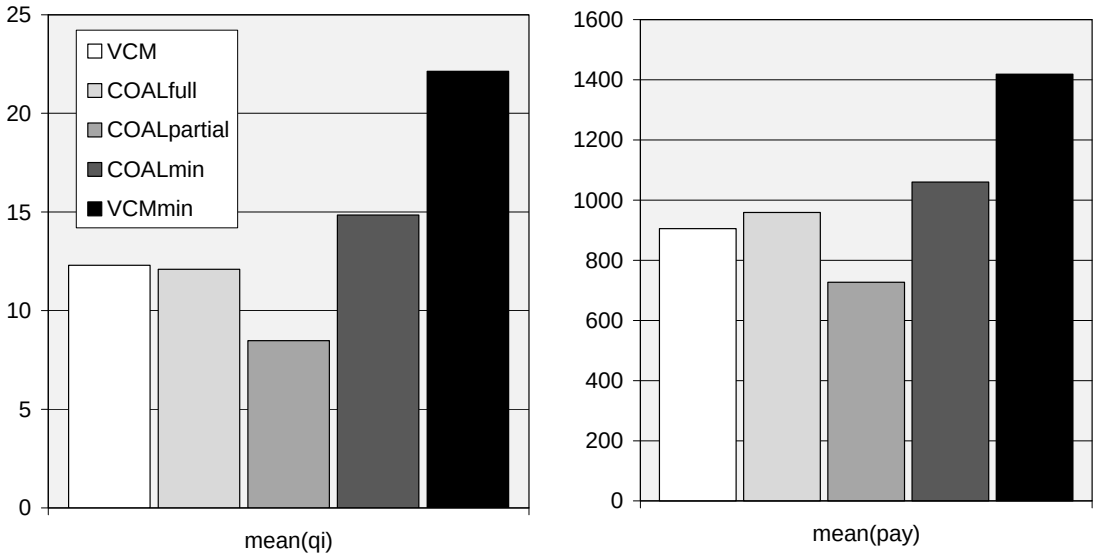


Figure 2.3: Average contributions for all treatments over time

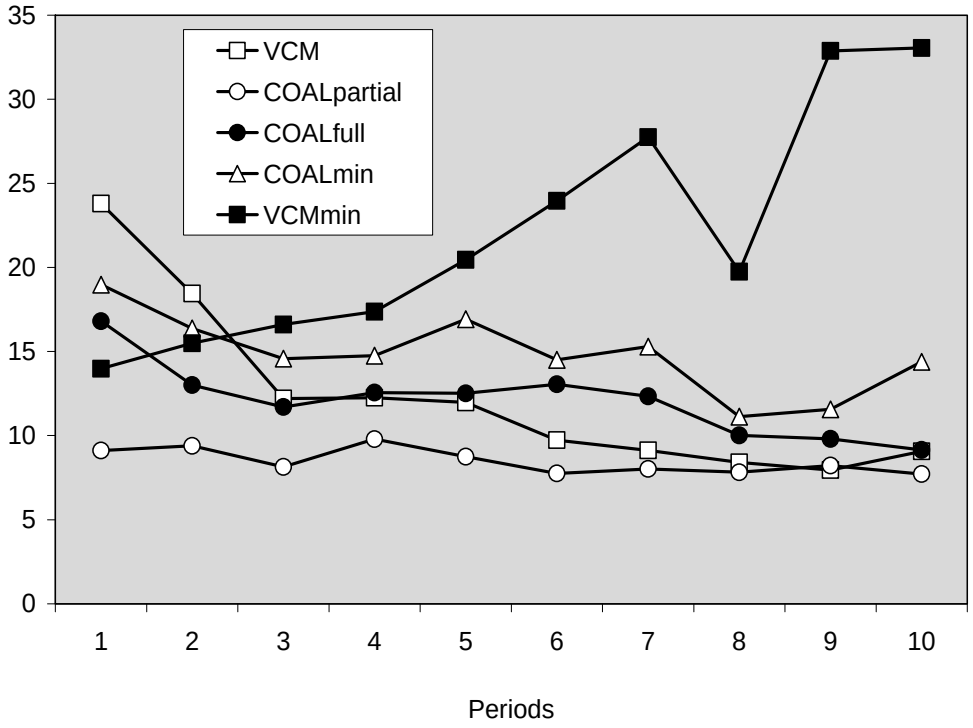
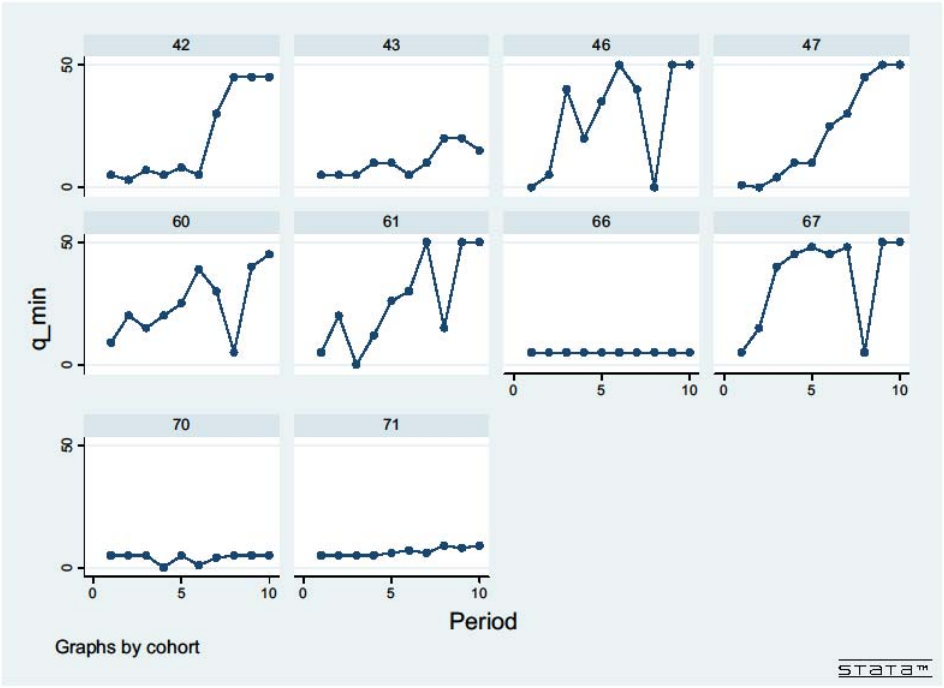
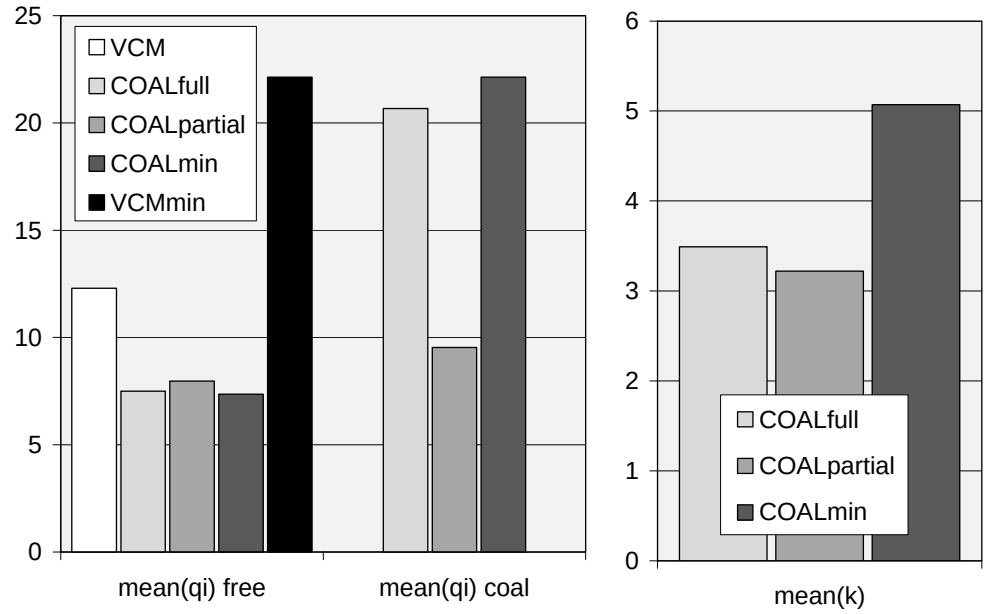


Figure 2.4: Binding minimum



Note: Binding minimum levels in *VCMmin* for each group over time

Figure 2.5: Average contribution levels and average coalition size



Note: Average contribution levels among coalition members (mean(qi)coal) and non-members (mean(qi)free) and average coalition size.

Figure 2.6: Average internalization ratios conditional on coalition size

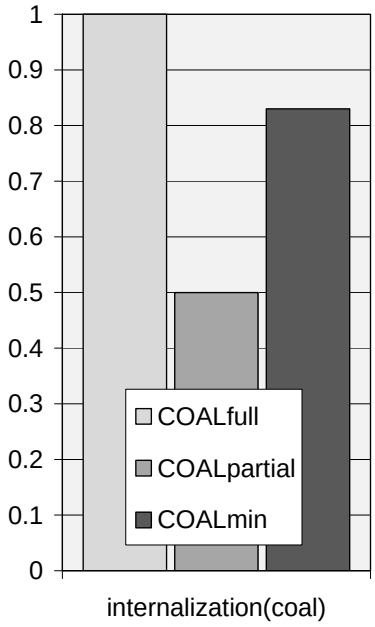
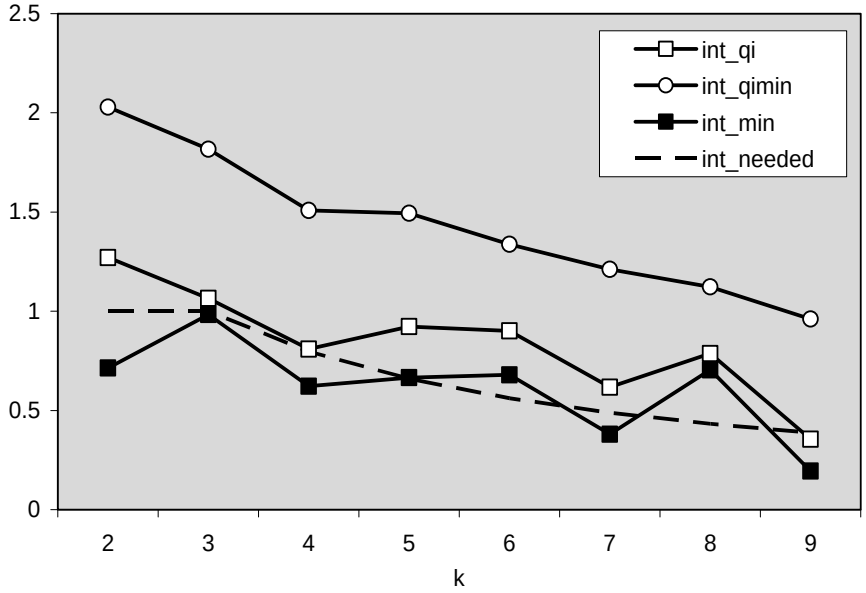
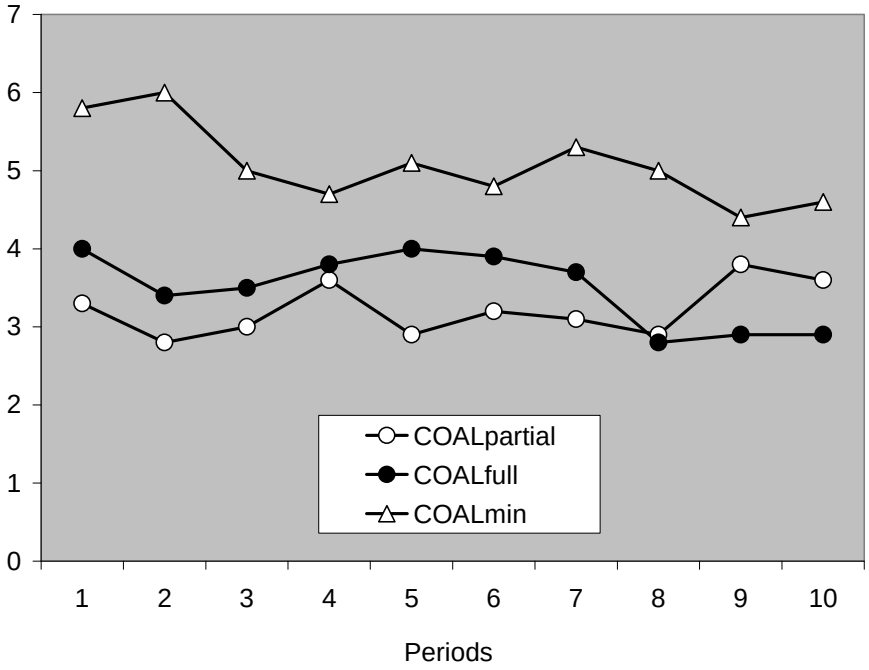


Figure 2.7: Average internalization ratios conditional on coalition size



Note: Average internalization ratios conditional on coalition size in *COALmin*: suggested minimum ratio (int_qimin), binding minimum ratio (int_min), chosen fraction of mutual benefits that are internalized in coalition (int_qi); the dashed line (int_needed) shows the internalization ratios theoretically required to stabilize the respective coalition size.

Figure 2.8: Average coalition size for all coalition treatments over time



2.6.3 Experimental instructions

Instructions for the *COALmin* treatment (translated from German)

Welcome to the Magdeburg Experimental Laboratory MaXLab!

Please read these instructions carefully and should you have any questions please signal us by opening the door or a show of hands. In the laboratory experiment you are taking part in, you can win money depending on your decisions and the decisions of your fellow players. Your payout from the experiment will be calculated in LabDollars (LD). The conversion rate between € and LD is **1:100**, i.e. 100 LD are €1. All your decisions made the experiment will remain **anonymous**. Only the experimenter will know your identity, but your data will be treated confidentially.

Rules of the game

Now you will learn more about the rules of the game you will be participating in. Altogether **10 players** take part in the game, so besides you there are 9 more players. Every participant faces the same decision making problem. Your task in the game, and also your fellow players' task, is to decide how many points you would like to contribute to a **joint project**. Your **payout** will be calculated as follows:

Your payout = –(your contribution to the project)^2 + 10·(sum of all contributions of all players to the project)

Example: If all other players have contributed an amount of 90 points to the project and you contribute an amount of 10 points, then your payout will be:

$-(10)^2 + 10\cdot(10+90) = 900$ LD

If, however, all other players contribute a total amount of 50 points and you do not contribute anything, your payout will be:

$-(0)^2 + 10\cdot(0+50) = 500$ LD

To simplify the calculation of your payout, you will find an excel-file called **'Simulator'** on your screen. You can enter your contribution and the **average** contribution of all other players and so quickly determine your payout.

There are **two stages** in this game. In **stage 1** you can decide whether you want to become a member of a coalition, i.e. if you want to join a coalition or not. Should you decide that you want to join a coalition you additionally can decide which amount should be the **minimum amount** each member of the coalition should contribute to the project. Also all other members of the coalition can state their desired minimum amount. The members will be informed about the proposals for the minimum amount of all members. If you are member of a coalition, **stage 2** will be to decide for yourself which amount you want to contribute. In this decision the **smallest** minimum amount of all members will form your **lower** limit of contribution. If you have decided not to join a coalition, **stage 2** for you will be to state your contribution to the project without any limitation.

The game consists of **10 separate rounds** in each of which you will play the same two-stage game. The nine other players you will interact with will be the same in every round. If the experiment is complete you will receive the **payout of one of the rounds** in € (according to the conversion rate stated above). The round to be paid out will be determined **randomly**. This means you should behave in **each** round as if it were the

round relevant for payout. In the beginning, **two trial rounds** will be played which are **not relevant for payout**. Independent of the course of the game you will receive €1 for your participation.

Control questions

If you have read the instructions and do not have any questions, please answer the following control questions (hint: use the simulator).

1. Please assume your contribution to the project is 10 points and the average contribution of all the other players is 15 points. How much LD will be your payout of this round?

   My payout is: _____

2. Please assume the average contribution of all other players is 5 points, which of the following amounts will result in the highest payout for you?

   O 5 points O 10 points O 20 points O 30 points

3. Please assume you want to maximise your payout, does it make sense to not contribute at all (meaning zero points) to the project?

   O yes O no

4. Please assume you and three other players have joined a coalition and all members have stated the following minimum contribution: 4, 88, 22, 56. In which range does your contribution to the project have to be?

   More than or equal ____ and less than or equal _____.

5. Is it possible that a member of a coalition has to contribute more than he proposed as his minimum contribution?

   O yes O no

6. Please assume all players chose the same amount, which of the following contributions results in the highest payout for all players (please check the according box)?

   O 10 points O 30 points O 50 points O 70 points O 100 points

If you have answered all questions, please signal us. We will then check your answers. The game begins when all participants in the experiment have successfully completed the test. Good luck in the experiment! The MaXLab-Team

3 Voting in international environmental agreements

3.1 Introduction

This chapter directly ties in with the previous chapter and analyses the effects of voting on the formation of international environmental agreements (IEA). As already pointed out, the IEA literature (e.g. Barrett 1994, Hoel 1992, Carraro and Siniscalco 1993) derives rather pessimistic predictions. If the difference in payoffs between the non-cooperative and full cooperative outcome is large only few countries are predicted to form a self-enforcing coalition. Hence, a self-enforcing coalition may only marginally improve upon the non-cooperative outcome. Finus and Maus (2008) suggest that public good provision and social welfare may increase if coalition members do not maximize their joint payoff by fully internalizing their mutual benefits but only partially internalize benefits. Lowering the effort level required from the members leads to higher participation which compensates for the lower effort level so that social welfare increases in equilibrium.

Assuming either full or partial internalization of mutual benefits, the theoretical literature has not paid that much attention to the question *how* coalition members determine their public good provision level. The experimental literature on coalition formation also rarely considers the negotiation process: Most experiments involve some form of voting to determine whether a coalition is to be implemented, but do not allow coalition members to negotiate and to agree on a (possibly suboptimal) effort level (Burger and Kolstad 2009, Kosfeld et al. 2009, McEvoy et al. 2010, see also Section 2.1). Different from these experiments, the study presented in Chapter 2 allows the coalition to endogenously determine their effort level by introducing a smallest common denominator rule: After the decision to participate in a coalition in the first stage, each member suggests a minimum contribution level in the second stage. The smallest proposal is then the binding minimum for all members.

This chapter extends the latter experiment by analyzing the welfare effects if coalition members apply majority voting to determine the minimum contribution level. To this end, qualified majority voting and simple majority voting are considered and the resulting public good provision levels are compared with those achieved by the smallest common denominator coalition (described in Chapter 2) where members apply a unanimity rule to determine their effort level. At first sight in line with theoretical

predictions, the experiment shows that the change of the voting scheme implemented in a coalition does not significantly change social welfare. However, changing the majority required to determine the terms of the agreement alters the depth and breadth of cooperation: Under the unanimity rule, coalitions are relatively large and implement moderate effort levels while coalitions with majority votes implement high effort levels but attract only few participants.

While the experimental game is designed to incorporate key real-world issues, it is necessarily simplistic for the sake of control and tractability. In particular, the experimental subjects face exogenously specified voting schemes, whereas these institutions in real-world negotiations evolve endogenously. Furthermore, just like in most of the theoretical and experimental literature, coalition members are assumed and forced to comply with the terms of the agreement.[10] While the former assumption can be expected to hamper cooperation, as endogenous institutional choice has been shown to enhance cooperation (e.g. Tyran and Feld 2006, Sutter et al. 2010), the latter is certainly an important precondition for cooperation. There are, however, arguments to justify this assumption. For example, customary law may require full compliance by coalition members and the enforcement of custom could be assumed to be solved outside the model in some kind of meta game (Barrett 2003).

The chapter is structured as follows: Section 3.2 provides the theoretical background. The experimental design is laid out in Section 3.3. Section 3.4 presents the results and Section 3.5 concludes.

3.2 Theoretical background

The game underlying the experiment is identical to the game in Chapter 2 and will be repeated here. It is standard in the IEA literature (e.g. Barrett 1994). An economy is considered with $i = 1,...,n$ identical individuals who may contribute to the production of a public good. Each individual's contribution costs are assumed to depend only on its

[10] As mentioned before, some experimental studies (MyEvoy et al. 2010, Kosfeld et al. 2009) allow for non-compliance in the contribution stage. However, they enforce the implementation of sanctions; thus, in a broader sense, they do assume compliance.

own contribution level while benefits are assumed to depend on the total provision of the public good. The payoff function for individual i is set by

$$\pi_i = b\sum_{j=1}^{n} q_j - cq_i^2/2 \qquad (3.1)$$

where q_i is i's contribution to the public good with $q_i \in [0, q_i^{\max}]$, $b > 0$ denotes the constant marginal per capita return from contributing to the public good, and $c > 0$ represents the slope of the marginal contribution cost curve. The full cooperative public good contribution level which maximizes social welfare is given by

$$q_i^* = bn/c$$

while the unique non-cooperative Nash equilibrium is given by

$$q_i^{NC} = b/c .$$

The Nash equilibrium involves dominant strategies such that each player's action does not depend on the contribution levels chosen by the remaining players. Throughout, interior solutions are assumed which require $q_i^{\max}$ to be sufficiently large. Since joint payoffs are maximized when all players chose $q_i^* = bn/c$ the players generally have an incentive to form a cooperative agreement to provide the public good.

3.2.1 Coalition formation and voting rules

The formation of coalitions is a very complex process. The negotiation process involves multiple stages, it may be little structured ex-ante and voting rules evolve endogenously with continuous updating of targets and expectations (Barrett 2003). The modeling of coalition formation in this setting is necessarily much simpler. It involves three stages: In the first stage ('participation stage'), each player chooses to join the coalition or not. Let k be the number of members with $1 \le k \le n$. In the second stage ('voting stage'), coalition members negotiate a minimum public good contribution for all members. Negotiations proceed in a way that all members anonymously vote on minimum contribution levels, starting from the level that maximizes joint payoffs, $q_i^{\min} = bk/c$, and decreasing until the required majority of members agrees with a certain contribution level. This level $q^{\min}$ is then the binding minimum contribution level for all members. In the third stage ('contribution stage'), all players determine their contributions to the

public good. Non-members are free to choose any contribution level. The choice of the public good contributions by the coalition members depends on the negotiations. Three different voting rules are considered: unanimity, qualified majority, and simple majority.

In the experiment, negotiations are initiated by requesting all members to suggest a minimum contribution level. After these minimum proposals $q_i^{\min}$ are received from all participating subjects, the agreement will require all members to provide at least (i) the smallest suggested level $q_i^{\min}$ (unanimity); (ii) the suggested level $q_i^{\min}$ upon which three quarter of members agree by proposing this or a higher minimum level (qualified majority); or (iii) the suggested level $q_i^{\min}$ upon which more than half of members agree by proposing this or a higher minimum level (simple majority). In all three treatments members are bound to provide $q_i \geq q^{\min}$.

In a subgame perfect equilibrium, players choose their actions in each stage by rationally anticipating the outcome of future stages and applying backward induction. Therefore, consider the final stage, the contribution stage, first. Non-members' payoff-maximizing decision does not depend on the coalition's effort and is given by $q_i^{NC} = b/c$. In contrast, members' payoff-maximizing contribution level at this last stage is given by $q_i = \max[q^{\min}, b/c]$. That is, members provide exactly the binding minimum as long as $q^{\min} \geq b/c$ is valid. This implies that it is weakly dominant for members to suggest the collectively optimal amount of $q_i^{\min} = bk/c$ in the intermediate voting stage. There are many other equilibria in weakly dominated strategies. In the case of unanimity, any binding minimum $q^{\min} < bk/c$ is established as equilibrium if at least two players suggest this level while all other players suggest a larger minimum. In the case of majority voting, any binding minimum level $q^{\min}$ can be established as weakly dominated equilibrium as long as enough players suggest that level. For convenience, all weakly dominated strategies shall be eliminated in the voting stage. This gives a unique subgame perfect equilibrium for all voting schemes: The coalition will consist of $k = 3$ players (provided $n \geq 3$) who maximize their joint payoff while $n - 3$ players stay outside the coalition and maximize their individual payoff. The proof follows straightforward from the comparison of payoffs to members and non-members according to (3.1) and the use of the concept of internal and external stability from the

IEA literature: Denoting the payoffs to members by $\prod^{M}(k)$ and the payoffs to non-members by $\prod^{NM}(k)$ given the coalition size k, the coalition is externally stable if no non-member has an incentive to join unilaterally, i.e. if $\prod^{NM}(k) > \prod^{M}(k+1)$ and the coalition is internally stable if no member has an incentive to leave unilaterally, i.e. if $\prod^{M}(k) \geq \prod^{NM}(k-1)$ (cf. Barrett 1994). The intuition behind this is not too difficult. The members of a coalition commit to joint-payoff maximization as long as each of them is at least as well off with all members cooperating as they would be if no player cooperated. That is, a coalition must be profitable for its members which is valid for all coalitions with $k \geq 2$. If a coalition is larger than the smallest profitable size, i.e. if $k > 2$, any member could leave the coalition and the remaining members would still find it profitable to cooperate. Members earn strictly more by leaving the coalition than by staying if $k > 3$ so these coalitions are not internally stable. In contrast, a coalition with $k = 3$ members is internally stable because members cannot do better by leaving. It is assumed that players stay in the coalition if they are indifferent to being a member or non-member. The coalition with $k = 3$ members is also externally stable because non-members are better off by staying outside than by joining it. Thus, although each player has an individual incentive to free-ride and is better off if *other* players participate in the coalition, the coalition is still formed in equilibrium because members get a higher payoff than without coalition.

3.3 Experimental design

The experiment was designed to investigate the effects of different voting schemes on the voluntary formation of coalitions. All treatments involved a ten-person public goods game and the payoff function for each player was given by $\pi_i = b\sum_{j=1}^{n} q_j - cq_i^2/2$ with $b = 10$, $c = 2$, $n = 10$, and $q_i \in [0,...,100]$.

The traditional voluntary contribution mechanism (*'VCM'*) served again as a control treatment which only contained a contribution stage in which players simultaneously and independently chose their contribution to the public good. The three coalition treatments involved three stages each: In the first stage, the participation stage, subjects decided on participating in a coalition. Decisions to become a member or non-member

were made simultaneously and independently. In the second stage, after being told the coalition size, all members negotiated the minimum amount that each member should contribute (voting stage). Negotiations took the form that all participants simultaneously and independently proposed a minimum contribution between 0 and 100. In the treatment called *'COALmin'* the smallest proposed amount became the binding lower limit for the members' contributions.[11] In the treatment *'COALqual_maj'* the proposed amount on which three quarter of members could agree by suggesting this or a higher contribution level became the binding minimum. In the treatment called *'COALsimple_maj',* the proposed amount on which the simple majority of members could agree by suggesting this or a higher amount became the binding minimum. In all three coalition treatments, members were informed about all proposed minimum amounts (arranged in descending order) and the binding minimum. Non-members did not make any decision at this stage and were only informed about the coalition size. In the third stage, the contribution stage, members and non-members chose their contributions to the public good. While non-members could freely choose their contribution level, members were bound to provide at least the binding minimum. At the end of the game, participants were informed about the average contributions provided by members and non-members and their own payoff.

Table 3.1 summarizes the key features of the experimental design and the number of subjects in each treatment. The experimental sessions were held in a computer lab at the University of Magdeburg, Germany, using undergraduate and graduate students recruited from the general student population (recruiting software Orsee, Greiner 2004). In total, 400 students participated in the experiment, of which 100 took part in each treatment. In each session, 20 subjects were seated randomly at linked computers (game software Ztree, Fischbacher 2007) and paid €1.00 as show-up fee. A set of written instructions and a record sheet were handed out. Experimental instructions included several numerical examples and control questions. The instructions involved a neutral frame for the context and language of the experiment in order to avoid potential biases subjects may have regarding certain frames (see Section 2.6.3 for instructions). The questions tested the subjects' understanding of the payoff function given in (3.1) to

[11] The treatments *VCM* and *COALmin* are also used in Chapter 2. They are repeated in this chapter for comparison reasons.

ensure that they were aware of the payoff-maximizing strategy and the dilemma situation. After reading the instructions and answering the control questions correctly, the subjects began the game. At the beginning, the 20 subjects were randomly assigned to one of two 10-person groups. The subjects did not know their fellows' identities but they knew that they remained within the same group of players throughout the game (partner matching). All decisions were made under completely anonymous conditions. Five 12-round sessions with two groups per session were conducted for each treatment with the first two rounds being practice. This resulted in 100 group level observations (10 groups and 10 non-practice rounds) and 1.000 individual level observations per treatment. During the game, earnings were presented in experimental dollars and 100 experimental dollars converted to one Euro. At the end of the experiment, one of the non-practice rounds was randomly selected for the determination of payments. Sessions lasted about 60-90 minutes and subjects earned on average €11.60 in the games. Earnings were paid in cash.[12]

3.4 Experimental results

The results section proceeds according to the stages of the game. It is first analyzed whether coalitions are actually formed and how many subjects participate under the different voting rules. I then study the individual minimum proposals, the binding minimum levels implemented in the coalitions, and the contributions chosen by members and non-members. Finally, the overall impact of coalition formation and voting on public good provision and welfare is presented by comparing average contribution and payoff levels in the coalition games and the voluntary contribution mechanism.

3.4.1 Participation in the coalitions

In line with previous coalition formation experiments, the first result shows that players almost always implement a coalition. Under the unanimity rule there are always at least two players who form a coalition. Under the qualified majority rule and the simple

[12] Overall, 18 out of 400 subjects earned negative payoffs in the games. In these cases, payoffs were cut off at zero and the subjects only received the show-up fee.

majority rule, at least two players form a coalition in 90% and 89% of the cases respectively. Previous experiments have shown that the grand coalition is particularly compelling as it eliminates the possibility to free-ride on the coalition's effort. In McEvoy et al.'s (2010) experiment, coalitions are more likely to form when they require full participation instead of the minimum profitable size. The experiment conducted by Kosfeld et al. (2009) shows that subjects are reluctant to implement coalitions where a subset of players has the opportunity to free-ride. The authors demonstrate that inequity aversion of at least some players may explain this behavior. It seems, however, that these subjects need a mechanism, which disallows the formation of smaller coalitions directly or gives subjects the power to reject them, in order to effectively discipline potential free-riders. As the present study does not offer such a mechanism large coalitions are rarely implemented: 81% of the coalitions in *COALmin*, 93% of coalitions in *COALqual_maj*, and 98% of coalitions in *COALsimple_maj* consist of six or fewer players. *No* group manages to implement the grand coalition consisting of all ten players.

The left panel in Figure 3.1 shows the average coalition size across all rounds for each coalition treatment. While in *COALmin* on average half of all players form a coalition (5.07), coalitions are significantly smaller in *COALqual_maj* (3.68) and *COALsimple_maj* (3.56) (Mann-Whitney test, $p<0.05$ and $p<0.01$ respectively).[13] The right panel in Figure 3.1 shows the average coalition size over time. While the coalition size in *COALmin* and *COALqual_maj* is relatively stable at around 5 and 3-4 respectively, in *COALsimple_maj* it is decreasing over time from over 5 to less than 3. The Spearman rank correlation between coalition size and number of rounds is negative and highly significant in the latter treatment ($\rho=-0.40$, $p<0.01$). It seems that some players are willing to join the coalition in the beginning but learn from experience during the course of the experiment. Table 3.2 presents the results of a probit estimation model of the individual decision to join the coalition. Players in *COALmin* are more likely to join than players in *COALqual_maj* and *COALsimple_maj*. The results furthermore show that players are more likely to join when they have already been a

[13] Statistical tests are based on group averages as units of observation. All reported tests are two-sided throughout the chapter.

member in the previous round and they are less likely to join if the coalition has agreed on a high minimum contribution in the previous round.

3.4.2 Minimum contribution levels inside the coalitions

The next point of interest is the minimum effort level a coalition can agree upon. The decision on the binding minimum level is particularly important since subjects' contributions are highly sensitive to the binding minimum: 63% of members' decisions on contributions are exactly at the minimum level and 81% are nearby, with the difference being 5 tokens or less. It is therefore evident that the binding minimum level has a large impact on the coalition's actual effort level.

Before turning to this, I will first report on the individual minimum proposals as they are the determinant for the binding minimum. A sensible measure to assess the minimum proposals is the benefit internalization ratio, i.e. the ratio of the minimum proposal compared with the joint-payoff maximizing level, $q_i^{\min}/(bk/c)$. The internalization ratios of the individual minimum proposals cover a wide range from 0% to over 200%. The individual minimum proposals do not significantly differ between voting schemes (Mann-Whitney test, $p>0.10$). In all coalition games, about a quarter of subjects suggest a minimum below 100%, about 60% suggest a minimum between 100% and 200% and the remaining subjects suggest more than 200%. Table 3.3 presents the results of a linear regression of the internalization ratio of individual minimum proposals. The regression results confirm that majority voting does not significantly affect the internalization ratio of the proposals. Thus, changing the required majority to determine the coalition's effort level does not change individual minimum suggestions but merely the outcome of the negotiations. The regression results furthermore show that the internalization ratio of the proposal is not significantly affected by coalition size and it is higher when the player has already made a high proposal in the previous round. These findings indicate that players have quite different views on what the coalition should do. Drawing from the theory part in Section 3.2, the prediction for payoff maximizing players is that they propose an internalization ratio of 100% when they have entered the coalition. A lower internalization ratio may be suggested by inequity-avers agents if they want to reduce unfavorable payoff differences to free-riders outside the coalition. Suggesting a higher minimum, on the

other hand, can be explained neither by self-interest nor by inequity aversion because, relative to joint-payoff maximization, such a minimum level would reduce the players' own payoff and increase inequality. The most plausible explanation is that these players try to lead by example. By joining the coalition and suggesting a high effort level, they might have hoped that other players would follow and the group would coordinate on a high provision level over time.[14] The following sections will show, however, that leadership does not pay out. The *average* internalization ratio of proposals decreases with larger coalitions: The Spearman rank correlation between average internalization ratio and number of rounds is negative and significant for all coalition games (at least $p<0.10$ each).

The internalization ratio of the *binding* minimum in the coalition is defined as the ratio of the binding minimum contribution compared with the joint-payoff maximizing level, $q^{\min}/(bk/c)$. On average, this ratio is 62% in *COALmin*, 109% in *COALqual_maj*, and 147% in *COALsimple_maj* as illustrated in Figure 3.2 (left panel). Thus, while the qualified majority rule leads to an average minimum level near the collectively optimal level, the unanimity rule produces a minimum *below* that level and the simple majority rule produces a minimum *above* that level. Figure 3.3 shows the average internalization ratio of the agreed minimum conditional on the coalition size (solid line). The internalization ratios are relatively stable for coalitions including 2-6 members and they tend to be lower for larger coalitions. Interestingly, while the theoretical model described in Section 3.2 clearly fails to predict the individual minimum proposals in the voting stage, it serves as a good prediction in the participation stage: Given joint-payoff maximization in the voting stage in *COALqual_maj*, the coalition size is not significantly different from the predicted $k=3$ members (t-test, $p>0.10$). Furthermore, the behavior observed in *COALmin* supports the suggestion of Finus and Maus (2008) that a lower effort level in the coalition can attract more members. According to their model, an internalization ratio of 62% would lead to a coalition consisting of $k=5$ members which is exactly what we observe (t-test, $p>0.10$).

[14] Contrary to theoretical predictions, leadership has been observed in several sequential public goods games (Gächter et al. 2010, Güth et al. 2007). Followers are found to positively respond to leadership but this reaction often does not suffice to compensate the leaders or to substantially increase overall efficiency (Sturm and Weimann 2008, Moxnes and van der Heijden 2003).

3.4.3 Contributions of members and non-members

The right panel in Figure 3.2 shows the internalization ratio based on the members' chosen contributions, $\sum_{i=S} q_i /(bk^2/c)$. With 83% in *COALmin*, 132% in *COALqual_maj*, and 167% in *COALsimple_maj* these ratios are higher than the ratios based on the agreed minimum because some members contribute more to the public good than the binding minimum. This is true even for the coalitions under the simple majority rule where members have already negotiated a very high minimum level.

Figure 3.4 shows the average public good contributions of coalition members and non-members. As expected, non-members contribute clearly lower amounts than members. Although non-members in *COALqual_maj* and *COALsimple_maj* contribute slightly more to the public good than non-members in *COALmin*, majority voting produces a higher inequality between members and non-members: Under unanimity, the members' average payoff is 28% lower than that of non-members (889 versus 1.236); the inequality is thereby close to the predicted 26%. In contrast, under the simple majority rule members earn a payoff which is remarkable 46% lower than the non-members' payoff (797 versus 1.478). Moreover, in the *COALsimple_maj* treatment, the members' payoff is significantly lower than the average payoff in the *VCM* treatment (Mann-Whitney test, $p<0.05$). That is, on average, those who join the coalition under the simple majority rule are even worse off compared to unilateral decisions. This does not hold for members in *COALmin* and *COALqual_maj*. It is conceivable that the high inequality and the low payoff of coalition members in *COALsimple_maj* might have a negative effect on the overall efficiency. The final result will therefore reveal the overall impact of the different voting schemes on the provision of the public good and welfare by comparing average contribution and payoff levels in the coalition games and the voluntary contribution mechanism.

3.4.4 Overall public good provision and welfare

All games perform better than predicted by theory leading to higher average contribution and payoff levels (t-test, $p<0.01$ each). The bird's eye view of cooperation is provided in Table 3.4 and Figure 3.5 which present average contribution and payoff levels across all rounds for each treatment. Average contribution and payoff levels in the three coalition games exceed those in the standard voluntary contribution

mechanism. A Mann-Whitney test shows that *VCM* gives lower contributions than *COALmin*, *COALqual_maj*, and *COALsimple_maj* ($p<0.10$, $p<0.10$, and $p<0.01$ respectively). Reducing the majority required to implement the minimum contribution level leads to small increases in contribution and payoff levels. Testing among the coalition treatments shows that *COALsimple_maj* gives higher contributions than *COALmin* ($p<0.10$). Identical comparisons follow for the average payoff levels.

Figure 3.6 shows the development of average contributions for each treatment over time. The contributions in *VCM* are decreasing over time which has also been observed in many other public good experiments (Ledyard 1995, Fischbacher and Gächter 2010). Though to a lesser extent, this downward trend is also observable for the three coalition games. Irrespective of the voting scheme, the possibility to form a coalition provides small benefits compared to the voluntary contribution mechanism. Comparing average contributions and payoffs over the last five rounds shows that the differences between the voluntary contribution mechanism and the coalition games remain significant (Mann-Whitney test, $p<0.01$ each) while there are no significant differences any more among coalition games. A series of linear regression models confirms that all three coalition games perform better than the voluntary contribution mechanism leading to higher contributions and payoffs. The differences become more pronounced towards the end of the experiment (see Tables 3.5 and 3.6).

3.5 Conclusions

The study presented in this chapter adds to the experimental literature on the voluntary formation of coalitions to provide public goods. Participants in the experiment have the possibility to form a cooperative coalition to provide the public good while non-members may free-ride on the coalition's effort. The effectiveness of any such coalition crucially depends on its ability to attract members and to implement a sufficiently high effort level to provide the public good. The aim of this experiment is to shed light on the negotiation process inside the coalition which determines the effort level and, thereby, affects the incentives to join the coalition. Different voting schemes are implemented in the coalitions to determine their effort levels, namely unanimity, qualified majority voting and simple majority voting. The resulting public good provision and payoff

levels are compared with those achieved by the traditional voluntary contribution mechanism.

The experimental results provide further evidence of the beneficial effects of coalition formation: All coalition formation games outperform the traditional voluntary contribution mechanism leading to higher public good provision and welfare. Theory suggests that the voting scheme does not matter for the outcome. As long as coalition members choose the dominant strategy by maximizing the joint payoff only few players are expected to join the coalition. At first sight in line with theoretical predictions, the experiment shows that a change of the voting scheme implemented in a coalition does not significantly change the public good provision level and welfare. However, changing the majority required to determine the terms of an agreement alters the depth and breadth of cooperation. Coalitions under the unanimity rule are relatively large and implement moderate effort levels, while coalitions with majority votes implement high effort levels but attract only few participants.

Though coalition members make similar minimum proposals under all voting rules, the pivotal players, whose minimum proposals form the binding minimum, differ between voting schemes. While coalitions under the qualified majority rule implement a minimum contribution near the predicted joint-payoff maximizing level, coalitions under simple majority implement a minimum above that level and coalitions under unanimity choose a minimum below that level. This lower effort required from the members under unanimity keeps the coalition size relatively high with averagely half of all players being in the coalition throughout the game. The experimental results hereby confirm that the terms of institutionalizing the requirements from a coalition are crucial for the capacity to attract participants (Finus and Maus 2008). Lowering the effort level inside the coalition leads to a higher and more stable participation rate. It furthermore leads to less inequality, as the burden of the provision of the public good is shouldered by more users, which may enhance the long-term acceptance of the institution.

The theoretical coalition formation literature mostly assumes that agents are purely self-interested.[15] The experimental studies provide some insight to the consequences arising from real (and possibly other-regarding) preferences. As already pointed out in the introduction, the experimental literature in this field is in need of further development

[15] Exceptions are for instance Lange and Vogt (2003) and Lange (2006).

and therefore the picture is still incomplete. Promising areas for further research include, for instance, asymmetric actors, endogenous institution design, and non-compliance. The coalition formation experiments so far show that people in the lab do not always act in line with the theory. Similar to the standard public goods games, the institutions typically perform better in the lab than in theory. The present experiment on coalition formation indicates that subjects have quite different views on what the coalition should do. Pure self-interest cannot explain all observed behavior; it rather seems that a significant share of people is willing to forego money in order to reduce inequality or to lead by example. But for all that, the experimental subjects are far away from the social optimum. The grand coalition is never implemented perhaps because subjects lack the possibility to prevent the formation of smaller coalitions. Relative to the difference between the full cooperative and the non-cooperative outcome, the average efficiency gain in all coalition games is 29-38% which decreases to 17-24% in the final round. The chief cause is the inevitable link between coalition performance and participation, as described above, which illustrates the importance of jointly considering these two requirements. In this respect, the experimental results support the view that under certain circumstances first-best solutions are not available, thereby bringing second-best solutions to the table which do not aim at coalition performance but rather try to transform the underlying game (Barrett 2003).

3.6 Appendix

3.6.1 Tables

Table 3.1: Summary of experimental design

Treatment	Stages	n	b	c	No. of subjects
VCM	contribution	10	10	2	100
COALmin	participation voting contribution	10	10	2	100
COALqual_maj	participation voting contribution	10	10	2	100
COALsimple_maj	participation voting contribution	10	10	2	100

Table 3.2: Probit estimation of individual participation decision

Variables	Rd. 1-10 ci
ci_lag	1.270***
	(0.0803)
k_lag	3.11e-05
	(0.0241)
COALqual_maj	-0.145*
	(0.0869)
COALsimple_maj	-0.197***
	(0.0602)
int_min_lag	-0.103***
	(0.0374)
outvoted_lag	-0.110
	(0.128)
round6_10	-0.0841
	(0.0521)
Constant	-0.545***
	(0.110)
Observations	2650
Clusters	30
Wald chi2	384.17***

Note: Robust standard errors in parentheses (clustered at group level),
significance *** p<0.01, ** p<0.05, * p<0.10.
Definition of variables:
ci = 1 if subject is coalition member, 0 otherwise,
ci_lag = 1 if subject was coalition member in the previous round, 0 otherwise,
k_lag = coalition size in the previous round,
COALqual_maj = 1 if subject plays in the *COALqual_maj* treatment, 0 otherwise,
COALsimple_maj = 1 if subject plays in the *COALsimple_maj* treatment, 0 otherwise,
int_min_lag = previous round internalization ratio based on the binding minimum,
outvoted_lag = 1 if subject's minimum proposal in previous round was below the binding minimum, 0 otherwise,
round6_10 = 1 if last five rounds, 0 if first five rounds.

Table 3.3: Linear regression of internalization ratios of minimum proposals

Variables	Rd. 1-10 int_qimin
int_qimin_lag	0.402***
	(0.0651)
round6_10	0.0155
	(0.0603)
k	0.00554
	(0.0336)
COALqual_maj	0.0246
	(0.0953)
COALsimple_maj	0.0101
	(0.0914)
Constant	0.776**
	(0.282)
Observations	763
Clusters	30
R-squared	0.238***

Notes: Robust standard errors in parentheses (clustered at group level),
significance *** p<0.01, ** p<0.05, * p<0.10.
Definition of variables:
int_qimin = internalization ratio of subject's minimum proposal,
int_qimin_lag = internalization ratio of subject's previous round minimum proposal,
round6_10 = 1 for the last five rounds, 0 for the first five rounds,
k = coalition size,
COALqual_maj = 1 if subject plays in the *COALqual_maj* treatment, 0 otherwise,
COALsimple_maj = 1 if subject plays in the *COALsimple_maj* treatment, 0 otherwise.

Table 3.4: Summary statistics of results

Treatment	Total			First 5 rounds			Last 5 rounds		
	q	π	k	q	π	k	q	π	k
VCM	12.3	905.2		15.7	1098.4		8.9	711.9	
COALmin	14.8	1060.1	5.1	16.32	1160.1	5.3	13.4	960.1	4.8
COALqual_maj	15.7	1107.0	3.7	17.8	1200.6	3.9	13.6	1013.5	3.5
COALsimple_maj	18.9	1235.8	3.6	22.8	1430.4	4.0	15.1	1041.1	3.1

Note: q = average contributions, π = average payoffs, k = average coalition size

Table 3.5: Linear regression of individual contributions

Variables	Rd. 1-10 qi	Rd. 1-10 qi	Rd. 6-10 qi
COALmin	2.551**	2.551**	4.520***
	(1.012)	(1.012)	(1.372)
COALqual_maj	3.360**	3.360**	4.698***
	(1.687)	(1.687)	(1.467)
COALsimple_maj	6.644***	6.644***	6.194***
	(1.664)	(1.664)	(1.268)
round6_10		-5.451***	
		(0.807)	
Constant	12.30***	15.02***	8.858***
	(0.616)	(0.782)	(0.595)
Observations	4000	4000	2000
Clusters	40	40	40
Wald chi2	20.05***	58.56***	58.56***

Note: Random effects estimation, robust standard errors in parentheses (clustered at group level), significance *** p<0.01, ** p<0.05, * p<0.10.
Definition of variables:
qi = subject's contribution,
COALmin = 1 if subject plays in the *COALmin* treatment, 0 otherwise,
COALqual_maj = 1 if subject plays in the *COALqual_maj* treatment, 0 otherwise,
COALsimple_maj = 1 if subject plays in the *COALsimple_maj* treatment, 0 otherwise,
round6_10 = 1 for the last five rounds, 0 for the first five rounds.

Table 3.6: Linear regression of individual payoff levels

Variables	Rd. 1-10 pay	Rd. 1-10 pay	Rd. 6-10 pay
COALmin	154.9***	154.9***	248.2***
	(58.95)	(58.96)	(82.22)
COALqual_maj	201.9**	201.9**	301.6***
	(94.02)	(94.03)	(90.03)
COALsimple_maj	330.6***	330.6***	329.2***
	(76.16)	(76.17)	(66.19)
round6_10		-290.7***	
		(41.57)	
Constant	905.2***	1,051***	711.9***
	(42.69)	(48.20)	(42.32)
Observations	4000	4000	2000
Clusters	40	40	40
Wald chi2	20.49***	63.05***	29.89***

Note: Random effects estimation, robust standard errors in parentheses (clustered at group level), significance *** p<0.01, ** p<0.05, * p<0.10.
Definition of variables:
pay = subject's payoff,
COALmin = 1 if subject plays in the *COALmin* treatment, 0 otherwise,
COALqual_maj = 1 if subject plays in the *COALqual_maj* treatment, 0 otherwise,
COALsimple_maj = 1 if subject plays in the *COALsimple_maj* treatment, 0 otherwise,
round6_10 = 1 for the last five rounds, 0 for the first five rounds.

3.6.2 Figures

Figure 3.1: Average coalition size across rounds (left) and over time (right)

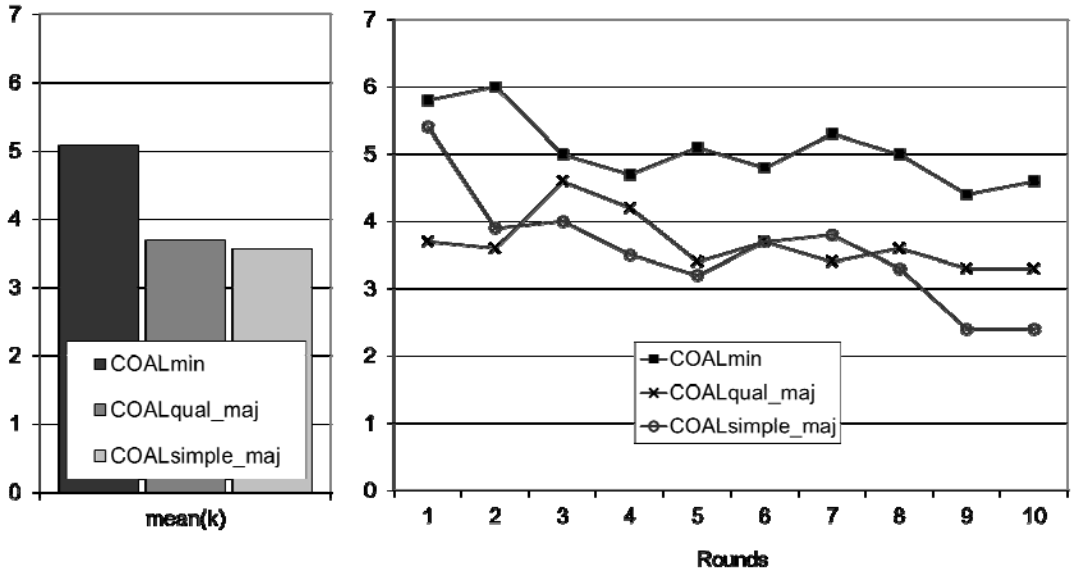
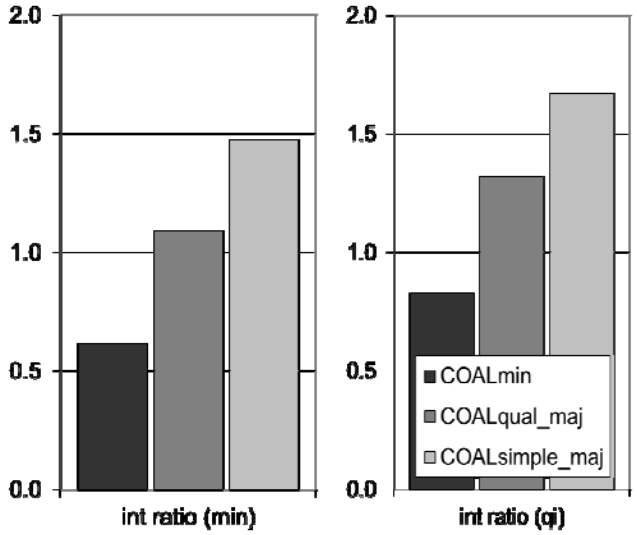
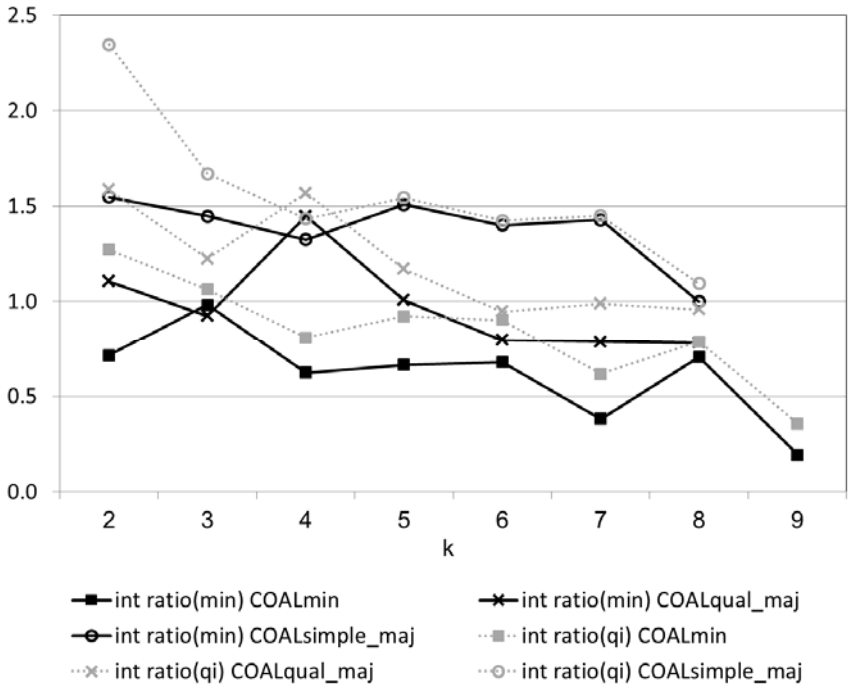


Figure 3.2: Average internalization ratio



Note: Average internalization ratio based on the agreed minimum contribution (left) and actual contributions (right).

Figure 3.3: Average internalization ratio conditional on coalition size



Note: Average internalization ratio based on the agreed minimum (solid line) and actual contributions (dotted line) conditional on coalition size

Figure 3.4: Average contribution levels:coalition members vs. non-members

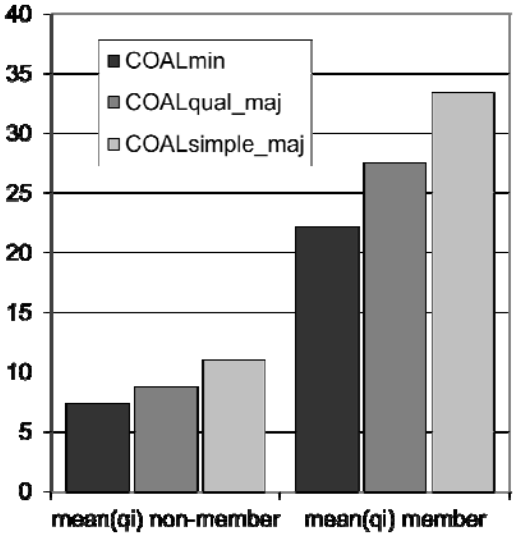


Figure 3.5: Average contribution and payoff levels

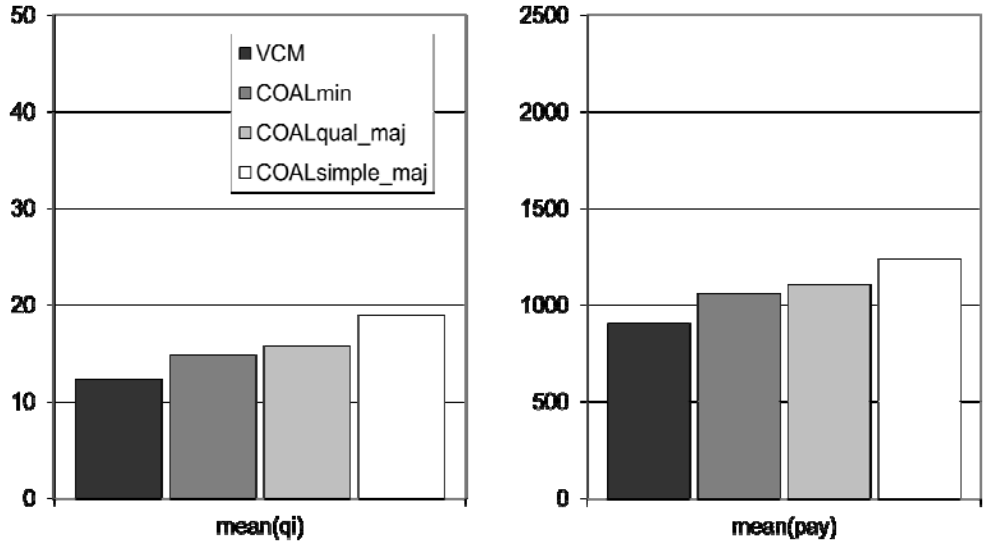
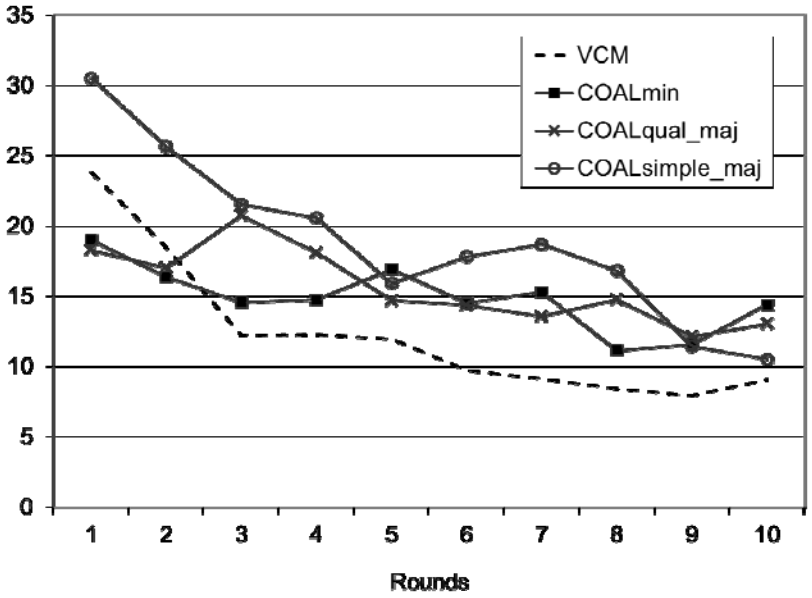


Figure 3.6: Average contribution levels over time



4 The role of inequality and pledges in a climate change coordination game

4.1 Introduction

This chapter is concerned with the drivers of coordination among groups of unrelated individuals faced with a public good game requiring multilateral effort in order to reach a target and avoid losses to all members. Similar to conventional coordination games, this game involves many equilibria including the one that leads to the efficient outcome. Therefore, the experimental subjects need to coordinate rather than to cooperate to reach the social optimum.

The experiment thereby builds upon the climate change game proposed by Milinski et al. (2008). These authors introduced two salient and distinguishing characteristics of individuals' attitude towards risk and time. On the risk-aversion side, it sets itself apart from commonly studied public goods games, as it involves investing in a public good (climate protection) in order to avoid a loss (hazardous climate change), rather than realizing a gain. Concerning the time dimension, a relevant trait of the climate problem is the tension between avoiding incurring immediate mitigation costs by not contributing to the public good today, and the long-term preference for a sound environment.

The focus here is on two further aspects that are absent in the original experiment but may prove determinant for its results: First, the experiment explicitly considers how the game is perceived in the presence of an asymmetric geometry for sharing the burdens of mitigation. That is, differences in the endowments originating from contributions (or lack thereof) in the initial rounds of play are introduced to convey the idea of differential wealth and responsibilities to players. Such asymmetries in wealth and carbon responsibilities among the actors might further impede coordination. Second, the players are empowered with the ability to make non-binding pledges before the actions are chosen. While these announcements do not carry any enforceable commitments with them, we postulate that they may facilitate the coordination among players towards the efficient outcome.[16] In coordination games communication is not simply 'cheap talk'

[16] See Bernasconi et al. (2010) for an experimental investigation of the role of expressive obligations in public good provision.

but may have an important effect on the ability to coordinate (Riechmann and Weimann 2008).

These additional aspects are deemed to be very important both at the theoretical and policy level. They are reminiscent of the real climate negotiations where countries have "common but differentiated responsibilities and respective capabilities" (UNFCCC 1992) and individual nations can make pledges in an uncoordinated manner. The two issues also appear to have played a determinant role in the negotiation discourse in the two latest Conferences of the Parties of the United Nations, which took place in Copenhagen and Cancún (COP 15 and COP 16). First, countries seem to have different views on fairness considerations in sharing the burden of the greenhouse gas mitigation costs: Developed countries are historically the main contributors to climate change, while in some newly industrializing economies, notably China, greenhouse gas emissions grow at an unprecedented rate. Therefore, the fair way to share the responsibilities among developing and developed countries in the containment of global greenhouse gas emissions is not obvious. In international climate policy, different notions of equity have been proposed: For example, the *egalitarian rule* incorporates the principle of equal per capita emissions, the *sovereignty rule* postulates the principle of equal percentage reduction of current emissions, the *polluter-pays rule* incorporates the principle of equal ratio between abatement costs and emissions, and the *ability-to-pay rule* stipulates the principle of equal ratio between abatement costs and GDP (Lange et al. 2010). The lack of consensus on equity principles has informed much of the United States – China exchanges on who is to be the first mover in the emission reduction game. Advocating that the other country was to take the lead in terms of timing and magnitude of greenhouse gas reductions on the grounds of reciprocity considerations, the two largest emitters worldwide (each accounts for roughly one fifth of energy related global CO_2 emissions) have managed to stay clear of binding commitments to date. Second, the Copenhagen Accord has introduced a non-binding 'pledge and review' mechanism where individual countries define voluntary emission reduction targets to reduce greenhouse gas emissions (or a correlated measure such as the carbon intensity of output) before 2020. Some 100 countries have already associated themselves with the Accord, of which 75 have also issued domestic goals for mitigation actions by 2020. The pledges of the participating countries were officially adopted at the subsequent climate conference in Cancún in December 2010.

The experimental results show that the real-world features introduced in the game have deep consequences on the coordination level. Both claims that the inequality disrupts and the pledges help coordination are supported by the data. The remainder of the chapter is structured as follows: Section 4.2 provides a brief discussion of the related literature along with the design of the present experiment. Section 4.3 is concerned with its theoretical underpinnings, followed by the Section 4.4 displaying the main results. Section 4.5 draws some concluding remarks.

4.2 Experimental design

Most experiments on public goods utilize linear public goods games, where participants have the option to invest a fraction of their endowments in a public good by means of a voluntary contributions mechanism (e.g. Ledyard 1995). Typically, the returns to the investment are equally shared among the participants according to the marginal per capita return. The experiment in this chapter departs from this standard formulation in many ways in order to create a setting which incorporates realistic issues faced by climate change negotiators. First, the provision of the public good is sequential, as multiple stages of contributions (10 rounds) are performed before the assessment of the group effectiveness in preventing simulated catastrophic climate change. Second, the objective of the game is to avoid a loss rather than creating a surplus by contributing to a public good (with higher group contributions leading to higher returns to the players). Here players' contributions to the public good make them collectively better off only insofar they are sufficient to reach a threshold (€120). All contributions below (or above) the threshold are wasted, as they fail to secure the keeping of the private accounts by the participants (or have no additional benefit if above the threshold). This feature leads to the next salient one, concerning the probabilistic nature of the losses. To account for the uncertainty involved in climatic change, the actions of the six players forming a group taking part in the game have consequences that are not deterministic. If they collectively fail to reach the target required to provide the public good, they will lose their savings on the private account with a probability of 50%. As both the climate threshold and the probability of the climate catastrophe are known, the players' primary

challenge here is to coordinate their contributions.[17] Finally the experiment is framed as a climate change game (see Section 4.6.3), i.e. the players contribute to a climate account and not to an abstract 'joint project' that often codifies the public good in experiments.

The probability of the climate catastrophe (50%) was chosen in the light of the results of the original experiment by Milinski et al. (2008), who developed and experimentally tested the above set-up. It is therefore worth taking a closer look at their experiment: Six individuals in a group are each endowed with €40. They decide on each of ten rounds of the game whether to contribute either €0, €2, or €4 to the climate account, with each group being presented with one of three different treatments corresponding to three probability of savings' loss: 90%, 50% and 10%. These yielded the following levels of success in avoiding simulated climate change: 50%, 10% and 0%. That is with the highest stakes, due to the larger gains in expected value from reaching the target, cooperation was highest and half of the participating groups were successful in collecting at least €120, while only one group out of ten succeeded in the 50% treatment and no groups succeeded in the 10% treatment. Note that the last result is not surprising from a rationality standpoint, as a player contributing €0 in all rounds would have expected earnings of €36 compared to earnings of €20 and €0 by following the remaining two pure strategies of €2/round and €4/round contributions. Only in the 90% treatment the social optimum coincides with the strategy of €2/round, as it would lead to certain earnings of €20 if adopted by all subjects, compared to expected earnings of €4 if all adopt the €0/round strategy and a certain outcome of €0 if they follow the €4/round strategy.

The basic experimental design in this chapter closely follows the design of Milinski et al. (2008) with six individuals playing together in a group, each endowed with €40. The players decided in each of the active rounds of the game whether to contribute either €0 ('no contribution'), €2 ('intermediate contribution'), or €4 ('high contribution') to the climate account. All groups were being presented with the probability of savings' loss of 50%. After each round the players were informed about all individual contributions

[17] Scott Barrett theoretically examines what happens if these (and other) conditions do not apply. For preliminary results see http://cbey.research.yale.edu/uploads/Environmental%20Economics%20Seminar/Yale%20seminar%20paper.pdf (accessed in July 2010).

and the aggregate group contribution in that round as well as the cumulative past contribution of each player and the group. As in Milinski et al. (2008), players were assigned nicknames in order to keep their identity private. Since the focus of this paper is to test in the lab for the role of inequalities in informing the debate on climate change, we introduced a series of treatments aimed at capturing features of asymmetry among participants in terms of wealth, past contributions and future commitment announcements.

In order to induce subjects to perceive the inequalities among them as the result of past actions, we modified the game described above by replacing the first three rounds with three *inactive* ones where half of the group had only the option of choosing a €4/round contribution, while the remaining three players could only select a €0/round contribution. That is, rather than externally imposing different endowments from the beginning of the experiment, players were all told they had the full €40 endowment before the start, but witnessed through the first three rounds a growing divergence between high and low contributors. As a result of these three inactive rounds, the players begin the active play consisting of seven rounds with substantial 'inherited' differences: Those who forcefully contributed €12 prior to round 4 had €28 left in their private accounts, while those who previously did not contribute anything to the public good found themselves with the entire endowment available for the ensuing seven rounds. This treatment is called *'Base-Fair'* and it is expected to convey a sense of responsibility to the relatively wealthy players, as their position is due to past free-riding. This situation is reminiscent of that of global CO_2 emissions, with developed countries owing much of their prosperity to past carbon-intensive industrialization, relative to developing countries with historically smaller carbon footprints and wealth.

In order to single out the effect on coordination of the introduced asymmetry, a *'Base'* treatment has been performed without such unequalizing redistribution. In it, subjects go through three inactive rounds where they all have no other option than to choose the intermediate contribution of €2 per round.

Finally, two treatments in which the subjects had the opportunity to make future commitment announcements are implemented. The *'Pledge'* treatment introduced two pledge stages to the symmetric case while the *'Pledge-Fair'* treatment introduced two pledge stages to the asymmetric case. In both pledge treatments it was common knowledge that the pledges were non-binding. The first pledge stage was after the

(inactive) first three rounds. The subjects simultaneously and independently announced their intended contributions for the subsequent seven rounds. Afterwards the players saw the 'intended climate account' which contained the individual contributions from the first three (inactive) rounds plus the individual pledges. Thereby they immediately detected whether the intended contributions would be sufficient to avoid catastrophic climate change. The second pledge stage took place after round seven. Similar to the first pledge, the players simultaneously and independently announced their intended contributions for the last three rounds and were subsequently informed about the 'new intended climate account' that included past contributions and the pledges. Table 4.1 summarizes the key features of the experimental design and the number of participants in each session.

The experiment was run in May 2010 at a computer laboratory at the University of Magdeburg, Germany. In total, 240 students participated in the experiment, whereby the pool consisted of a mixture of students with an economic or business major (60%) and students with a non-economic major (40%). Most of the students were experienced as they had participated in three or more experiments before (88%) while only few students were inexperienced (12%). Sixty subjects took part in each treatment. No subject participated in more than one treatment. Sessions lasted about 60 minutes. For each session, we recruited either 12 or 18 subjects using the ORSEE software (Greiner 2004). Each subject was seated at linked computer terminals that were used to transmit all decision and payoff information (Ztree software, Fischbacher 2007). Once the individuals were seated and logged into the terminals, a set of written instructions was handed out. Experimental instructions (see Section 4.6.3) included a numerical example and control questions in order to ensure that all subjects understood the game. At the beginning of the experiment subjects were randomly assigned to groups of six. The subjects were not aware of whom they were grouped with, but they did know that they remained within the same group of players throughout the ten rounds. After the final round, the players were informed whether the group had successfully reached the threshold of €120. Afterwards they were asked to fill in a short questionnaire. The questionnaire was designed to elicit the players' impressions and motivation during the game, as well as the general opinion about climate change policy (see Section 4.4.3). At the end of the experiment, one of two table tennis balls was publicly drawn from a bag by a volunteer student. If there was the number 1 on the ball, all players in the groups

that had not reached the threshold kept the money (that was left on their private account). If there was the number 2 on the ball, these players lost their money. Out of the 20 groups which did not reach the threshold 11 groups were in good luck and kept their money while 9 groups were in bad luck and lost their money. No show-up fee was administered. On average, a subject earned €17.23 in the games; the maximum payoff was €40 and the minimum €0.

The money allocated to the climate account was used to buy and withdraw CO_2 emission certificates traded in the European Union emission trading scheme (EU ETS).[18] If a group had successfully reached the threshold, all of the climate account money was used in this way. In case of a failing group only half of the climate account money was used for emission certificates. Thereby, we introduced a specific field context to the experiment which made the task more realistic and might increase the participants' motivation. The experimental instructions contained a short explanation of the EU ETS and the above mentioned rules. It was announced furthermore that the overall amount of certificates as well as the purchase and suspension documents could be found on a specific website shortly after the experiment. Overall, €3,248 were spent for emission certificates which corresponds to 212 tons of CO2 given a price of 15.3 €/ton.[19]

4.3 Theoretical background

The multiplicity of equilibria in the game makes classification virtually impossible. The game utilized here is a modified n-person stochastic threshold public goods game, with a total of ten rounds of which only seven allow freedom of choice over the three possible actions. Both contributing nothing and 2€ in each round are (symmetric) Nash equilibria, since unilateral deviations are nonprofitable. Of course, depending on the round and the path that has led to it, a round contribution of €4 bringing the individual sum above €20 may still be optimal if successful in guaranteeing that past investments were not wasted. Conversely, if at a certain stage the target becomes out of reach

[18] For information about the EU ETS visit the European Commission official website http://ec.europa.eu/environment/climat/emission/index_en.htm (accessed in September 2010).
[19] See http://www.zew.de/en/topthemen/meldung_show.php?LFDNR=1517&KATEGORIE=2; for emission certificate prices visit http://www.eex.com/en (accessed in September 2010).

because of insufficient members' contributions, one's best response is to stop contributing and play the odds.

Given the 50% probability of loss, conditional on the group failure to collect €120, the take home expectations when choosing not to contribute are given in the second column of Table 4.2. In the symmetric treatments, borrowing the wording from Milinski et al. (2008), "each course of the game that leads to exactly reaching the target sum of €120, irrespective of who[m] contributes how much as long as each player invests" at most €22 overall, is a Nash equilibrium. This is since the latter investment translates into a payoff of €18, which is above the €17 that are expected when all players choose not to contribute to the public good (second column in Table 4.2). Therefore, individuals can maximize the pay at the end of the game by choosing the intermediate level of contribution, invest a further €14 over rounds 4 to 10 and secure the €20.

In the asymmetric treatments, due to the different disposable endowments of rich and poor players, the former gain the most when the climate is protected with equal burden sharing in the active rounds (€26, resulting from an investment of €14 in the active rounds). Relative to the no contribution equilibrium, it is more appealing as the rich will be at least as well off when investing at most €20. The poor, on the other hand, do not stand to gain from the equal burden sharing in the active rounds, assuming risk neutrality. Given the early rounds contributions of €12, only by investing less than €14 in the active rounds (and the group still reaching the threshold) can these players have a higher expectation than by not investing in the public good.

The game design allows for such a redistribution. Since the wealthy players have a surplus of €12 in the 2€/active round equilibrium relative to the other, they can in principle forgo part or all of it by investing more and allowing the poor to correspondingly decrease their investment. In the case of full redistribution, both types of players have a final payoff of €20, which for the rich is still rational in the sense of not being welfare diminishing relative to not contributing anything.

4.3.1 Game trade-offs between risk aversion and inequity aversion

For illustrative purposes, a hypothetical scenario is shown in Table 4.3. Assume the group has just completed round nine, with an aggregate contribution of €108 (i.e. they

are on track). Assume further that four players stick to €2 in round ten, unilaterally bringing the account to €116. If the two remaining players were convinced, say due to previous contribution patterns, that only the two of them would consider deviating from the intermediate €2 contribution in the last round, they would be facing the figures displayed in Table 4.3.

Ultimately, the decision depends largely, in this situation, on the degree of risk aversion and on mutual expectations. A third driver of behavior should not be overlooked, namely moral heuristics. Especially if previous departures from symmetric burden sharing introduced the need and led to altruistic acts by some of the players, inequity aversion might motivate the latter to refuse participation in an unfair outcome, even at a deer cost to them and the others. In this experimental setting, these situations are expected to arise more frequently in the treatments with initial unequalizing rounds, as they are likely to result in greater disparities among players (due to the constrained behavior in the early rounds). Inequity aversion may be determinant in guiding the decision based on Table 4.3-type of scenarios. If for example a player is risk-averse but strongly resists disadvantageous inequity (has a high alpha parameter in Fehr and Schmidt 1999 terminology), he or she will be unwilling to compensate for the actions of the risk-seeker(s).

Let us return to the example shown in Table 4.3 in order to evaluate how inequity aversion may steer the end result towards successful or unsuccessful coordination. In its absence, a risk-seeking player believing the opponent to be risk-averse (i.e. placing a high probability on his/her choosing the high round contribution of €4), might be inclined to take a chance and choose €0 in the last round. Symmetrically, a risk-averse individual, say the column player, fearing to see the certainty of a gain jeopardized as a result of free-riding, may well opt for contributing €4. In that case, the two contributions would offset each other and €120 would be reached (top right entry in Table 4.3). This situation is reminiscent of the snow drift game, which differs from the prisoner dilemma game in that unilateral action, while not as desirable as shared cooperation, still provides a benefit to its pursuer.[20] However, if risk aversion is dominated by inequity

[20] Kümmerli et al. (2007) argue for the omnipresence of these situations in human working life, with the following example: "two scientists accomplishing a research project would each benefit if the other invests more time than oneself in the writing of the paper reporting the collaborative work. But if one of the collaborators does not contribute at all, the best option probably remains to do all the work on one's

aversion, the column player may choose either the €2 or the €0 contribution, if believing the row player to free-ride, thus leading to the highly inefficient outcome represented by the top left and top middle cells. Highly inefficient since they do not guarantee certainty of success, notwithstanding the substantial contributions, which on average are close to €2/round per player.

4.3.2 Impact of the computerized rounds

As discussed in Section 4.2, in the two symmetric treatments the players witness three rounds of unavoidable €2 contributions, while in the remaining two asymmetric treatments the players undergo three unequalizing rounds resulting in half of the group being wealthier than the remaining half. At the group level, independent of the treatment, they contribute €36 to the public good before round four begins, keeping them on track with respect to the threshold. What is the impact of this mechanism on the attainable game equilibria? First of all, it makes the achievement of the threshold collectively optimal as otherwise the already invested €36 would have been wasted.

Let us consider the case of symmetric contributions constrained to the intermediate round contribution of €2. Of the two symmetric Nash equilibria from the setup in Milinski et al. (2008), corresponding to all players contributing either €2 or €0 per round, the latter is no longer available. This difference may promote coordination, as the unrecoverable individual contribution of €6 early in the game could in principle steer away individuals from no contribution towards the intermediate contribution.[21]

For what concerns the remaining two asymmetric treatments, both symmetric Nash equilibria disappear, as not only the all selfish equilibrium is ruled out by the first three rounds (although now three players do have the option to avoid any contribution), but also the one where all players contribute €2/round. This happens since half of the group begins round four with a sunk investment of €12, while the remaining players are unbound. The difference with respect to the symmetric case is stark, as it arguably

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own." These tradeoffs, which also apply to the sharing of the global climate bill, are captured by the game analyzed here.

[21] In the experiment by Milinski et al. (2008), participants of the 50% treatment, which were not bound to the fair amount in rounds one to three, contributed on average > €1.5/round. This suggests that the selfish Nash equilibrium was not popular even in the absence of the discussed mechanism.

introduces profound differences in the motivations of the two subgroups to provide the public good.

Before turning to it, at the risk of oversimplifying the complexity of the 6-person, 10-round game, Table 4.4 presents payoff matrices with the aim to highlight some key characteristics of the game in Milinski et al. (2008) and in the present work. The left matrix concerns the former, while the centre and right matrices respectively summarize the outcome of interactions in the symmetric and asymmetric games introduced here. For the sake of presentational clarity, the analysis is simplified by assuming that two subgroups of three players choosing the same strategy form, effectively reducing the type of interactions to those present in the familiar 2x2 formulation. That is, the three players in each subgroup act identically, as if they tacitly coordinated on the same choices. Moreover, in Table 4.4 players can only choose between either free-riding in all active rounds (no contributions), or always contributing the intermediate amount of €2/round.[22] This simplification allows analyzing the game as if it was a one shot game, where people simultaneously reason on the outcome from picking one of two strategies leading to the corresponding group level Nash equilibria (keeping in mind the above discussion on the no longer attainable Nash equilibria).

Comparing the three cases, we notice that, when choosing between no contribution and the intermediate contribution in the respective games, best response behavior leads to two pure strategy Nash equilibria where all players coordinate on either the free-riding or the intermediate €2 strategy, irrespective of which matrix we consider. However, while in the one simplifying the game in Milinski et al. (2008), both are payoff equivalent, with the €2/round equilibrium being a weak Nash equilibrium and the €0/round equilibrium being strict, in the symmetric game in the centre of Table 4.4 the intermediate contribution equilibrium is payoff dominant (and both are strict). Lastly, in the asymmetric one, the intermediate contribution equilibrium is again payoff dominant, although it is weak, unlike the no contribution equilibrium which is strict. This analysis confirms that the games experimentally tested here can be seen as coordination games of the Stag Hunt kind, with the trade-off between social cooperation and safety being

[22] It is important to stress again that, while the all fair-sharer equilibrium is present in all three matrices in Table 4.4 (top-left cells), the one where all players choose the selfish act in each of the ten rounds (bottom-right cell in the first matrix) is not preserved in either of the games introduced here. In other words, due to the introduction of the computerized rounds, the €0 contribution is no longer attainable in the remaining two matrices.

represented by the more rewarding €2/round strategy versus the safer €0/round strategy, which does not require cooperation to succeed.[23]

Against this background we can summarize the following hypotheses for the game:

(i) pledges increases successful coordination by helping players to coordinate on whether to provide the public good or not and

(ii) inequality disrupts coordination due to the different incentives of the two types of players (see Table 4.2).

In other words, we expect more groups to reach the threshold of €120 if players have the opportunity to pledge their planned contribution than if they do not have this opportunity; and we expect fewer groups to reach the threshold if the players are asymmetric than if they are symmetric with respect to their endowment and responsibility.

4.4 Experimental results

The results in Figure 4.1 show a clear ranking in terms of success of coordination as measured by the percentage of groups who contributed at least €120 to the climate account. Both hypotheses are supported by the experimental data: The two pledge treatments are well above the corresponding ones without pledges. In the absence of the mitigating effect of the pledges, which proved to be an important vehicle of intentions among the participants, income inequality reduced the prospects of success (5/10 successful groups in the *Base* treatment vs. 2/10 in *Base-Fair*). In the latter, investment by the failing groups was €15 higher (n=13, p=0.0393, two-sided Mann-Whitney-Wilcoxon (MWW) test), indicating that inequality also led to poorer coordination on the non-provision outcome. Allowing subjects of the asymmetric treatment to announce

[23] Skyrms (2001) has the following interpretation of the game: "In the Stag Hunt, what is rational for one player to choose depends on his beliefs about what the other will choose. Both stag hunting and hare hunting are equilibria. [....] A player who chooses to hunt stag takes a risk that the other will choose not to cooperate in the Stag Hunt. A player who chooses to hunt hare runs no such risk, since his payoff does not depend on the choice of action of the other player, but he foregoes the potential payoff of a successful stag hunt. Here rational players are pulled in one direction by considerations of mutual benefit and in the other by considerations of personal risk". The game analyzed here adds a further layer of complexity, as the option that doesn't require cooperation to succeed, namely the always defect strategy labelled Selfish in Table 4.3, is not entirely safe due to the associated probabilistic payoff; Fair, on the other hand, is risky in terms of reliance on coordination, but safe with respect to the ensuing payoff.

future contributions significantly raised the success rate in collecting the target sum (from 20% in *Base-Fair* to 60% in *Pledge-Fair*, n=20, p=0.085, one-sided Fisher's exact test). The latter success rate (60%) is not significantly different from the 70% achieved by participants of the symmetric *Pledge* treatment (p=0.500), indicating that inequality is a less serious threat once a coordination mechanism is introduced.

While non-binding, the amounts pledged were close to actual contributions: Following the second pledge, average cumulative contributions in rounds 8-10 were €31.8 and €30 in *Pledge-Fair* and *Pledge* respectively, and the stated amounts were €32.6 and €29.6. In support of their role as lubricant of collaboration, we find that the closer the pledges to actual contributions, the higher the probability of success: As the difference between the player's pledged amounts and cumulative contributions increases, the probability of the player being in a successful group decreases significantly (see Figure 4.3). The top panels in Figure 4.3 visually confirm the link between success and adherence to the initial pledge: For the successful groups that provided the public good the gap is tighter than for the unsuccessful ones, as indicated by the dispersion around the bisector. Similarly for the second pledge, greater clustering around the bisector takes place in successful groups than in unsuccessful ones (see also probit estimation results in Table 4.7). The following sections take a closer look at between and within treatment differences, and find supporting evidence for the above claims, as well offering explanations based on the underlying patterns.

4.4.1 Trajectories of public good contributions

Much of this section's analysis is based on Figure 4.2. In it, the contribution trajectories resulting from averaging those of the participants of the four treatments are contrasted with the symmetric trajectory that would arise if all subjects chose the intermediate €2 strategy, therefore collecting €12 per round. Note that each curve concerns eight rounds, the first of which represents the group contribution in round three, set by default at €36 for all treatments, after which each subject has the freedom to choose the round contribution between €0, €2, and €4.

The experimental subjects displayed a significant amount of variation, with some groups contributing little to the public good (the group that came closest to the no contribution equilibrium collectively contributed only €12 in the seven active rounds),

and others surpassing the threshold (the maximum was €126). Nevertheless, each treatment was characterized by substantial differences in terms of success rate in simulated climate catastrophe avoidance. Five of the ten groups participating in *Base* were successful, contributing on average €122.4, while the remaining five fell short by contributing €70. The ten groups as a whole contributed €96.2 ± 32.5 (mean ± error), as shown in Figure 4.2. As expected, the *Pledge* treatment proved effective in facilitating coordination, even if based on non-binding commitments. Successful coordination on the target increases to 70%, with all groups contributing €103.6 ± 29.6, stemming from the €121.1 set aside by the seven groups who reached the target and €62.7 by the remaining three. Participants of *Base-Fair* provided €100.6 ± 21.8, which is below the provision level in both pledge treatments (the highest across treatments was achieved in *Pledge-Fair*, with 108 ± 21.8), reflecting the positive impact of the pledges discussed above. Notably, this impact is higher when considering the asymmetric treatments (+40% success rate from *Base-Fair* to *Pledge-Fair*), with respect to the symmetric ones (+20% success rate from *Base* to *Pledge*). Table 4.5 provides linear regression results on individual contributions across all treatments. The results indicate that, while the treatments matter for the probability of success, they are of less importance for individual contributions.

While in *Base* and *Pledge* failing groups provided only €70 and €62.7 respectively, failing groups participating in *Base-Fair* and *Pledge-Fair* contributed a remarkable €95.5 and €88, despite the lower success rate in the latter two. This suggests that the role of the asymmetric endowments is twofold: It disrupts coordination by rendering the process more complex, but the increased failure rate is not simply the result of a decision by a larger proportion of group members to opt for a no contribution strategy in the hope of high earnings. Many groups in these two treatments clearly tried to reach the €120 threshold until the last rounds, therefore increasing average contribution relative to the failing groups in *Base* and *Pledge*, who often behaved as if they tacitly agreed on gambling with the probability, due to low contributions in the early rounds. In fact 6/8 failing groups (75%) in *Base* and *Pledge* combined provided ≤ €70, while in the corresponding asymmetric treatments only 2/12 failing groups (17%) provided ≤ €70. In other words, the inequality undermined the groups' ability to combat simulated climate change damage, but not their motivation, which is actually higher than in the symmetric treatments.

4.4.2 Inequality

We have seen that inequality impedes coordination among the players. This section analyzes in more detail how the groups in the asymmetric treatments *Base-Fair* and *Pledge-Fair* handle the inequality and compare the handling between groups which successfully reached the threshold and those which did not.

Successful groups were strikingly effective in eliminating the inherited inequality (see Figure 4.4): Both the rich players and the poor players contributed on average precisely €20 to the climate account (two-sided MWW test, n=16, p=0.8195). Thereby, 92% of the rich players and also 92% of the poor players gave €20 or more. Conversely, the difference in contributions between rich and poor is significant in failing groups (€12.83 by the rich and €18.17 by the poor, n=24, p=0.0138), indicating that such redistribution did not take place. 47% of the poor players and only 17% of the rich players paid €20 or more. However, the rich players did not completely refuse to invest. The majority (53%) invested €14 or more. That means they were not willing to eliminate inequality completely. The poor players, on the other hand, were not willing to compensate for the missing investment. Obviously the rich and the poor had different views on what is the appropriate contribution for each type of player. In the end, the persistence in their different viewpoints was crucial and caused the shipwreck of the group. We will come back to this point in the next section.

Interestingly, even in the absence of communication, participants of successful groups tacitly coordinated on an equalizing redistribution which offset the original endowment asymmetry. However, the pledges appeared to be of great help since in the *Pledge-Fair* treatment 75% of the groups managed to eliminate inequality and reach the target that while in the *Base-Fair* treatment only 33% of the groups managed to do that.

The above findings shed light on the importance of countering inequalities and on the need for channels to vehicle intentions, if successful coordination on a costly group effort is the objective. It is particularly salient to see whether timely redistributive signals by the rich are associated with effective coordination. On average, rich players in successful groups contributed €3.17 in round 4, while they contributed €2.06 in failing groups. This difference is significant (two-sided MWW test, n=20, p=0.0054). Likewise, cumulative contributions by the rich over rounds 4 to 6 were €9.83 in

successful groups, while the rich in failing groups appeared to be unwilling to commit to early redistribution and invested only €6.67 (n=20, p=0.0040). These differences indicate that early leadership by those with greater means (and responsibilities) is a key to reach the target.

4.4.3 Questionnaire analysis

After the experiment subjects were asked to fill in a questionnaire about the motivation for their contribution decisions during the game and their general opinion about climate change (see Tables 4.8 and 4.9 for summary of responses and Table 4.5 for regression results). The summary of the players' motivation for their contribution decisions during the game is a bit complicated because, on the one hand, open questions were used to elicit the motives and, on the other hand, the motives obviously depend on the respective group performance. The qualitative categorization of responses reveals that the majority of players is primarily motivated by the achievement of the threshold (43%), fairness considerations (18%), material self-interest (15%), and the past group performance (14%). Understandably, the poor players in the asymmetric treatments *Base-Fair* and *Pledge-Fair* care more about fairness than the rich players (22% versus 15%) and more about the past group performance (27% versus 14%). In the final round the players are primarily motivated by the achievement of the threshold (42%), material self-interest (18%), the hopelessness to reach the threshold (14%), and fairness considerations (11%). The self-reported motives are in line with the actual behavior in the game, e.g. people stating that fairness was the most important reason often contributed €20 to the climate account while people stating the self-interest was their primary motive mostly gave less than €20. The self-reported motives furthermore help to understand why some groups did not reach the threshold. Comparing the successful groups that reached the threshold and the groups that did not, fairness considerations were more important for the successful groups (23% versus 13%) as well as the achievement of the target (52% versus 35%) while self-interest (9% versus 20%) and the past group performance (8% versus 21%) were less important.

In order to elicit players' fairness perceptions, the subjects in the asymmetric treatments were asked whether they agree with the following statement: "Those who began in round 4 with a starting capital of €40 should pay more into the climate account in the

following seven rounds than the other players". Overall, 76% of subjects agree with that statement, 10% disagree, and 14% neither agree nor disagree. Considering, again, the difference between successful groups and failing groups, we observe that the rich's fairness perceptions and willingness to redistribute were decisive for success: Being confronted with the above statement 75% of the rich in successful groups but only 53% of the rich in failing groups agreed with that claim (one-sided Fisher's exact test, n=60, p=0.071). Therefore the rich's opinion in that question and the group's success are significantly correlated (Spearman's correlation test, n=60, p=0.0855).

Furthermore, the acceptance of the above claim is highly dependent on the player's wealth (Spearman's correlation test, n=120, p=0.0002). In numbers: 90% of the poor but only 62% of the rich support the claim for redistribution (one-sided Fisher's exact test, n=120, p=0.000). In another question, subjects in the asymmetric were asked "What would you consider a fair average investment for the last seven (active) rounds for those beginning with €40 and for those beginning with €28?" Possible answers include €0, €1, €2, €3, and €4. Almost all of the poor players (95%) perceive €3 as the fair amount for the rich players while only 72% of the rich players share this perception. Similarly, only 23% of the poor players perceive €2 as the fair average contribution for the poor players while 42% of the rich players state that this would be the fair amount. These specific amounts (€3 for the rich and €2 for the poor) are particularly important because they reflect the application of the different equity principles. In our game, the *egalitarian rule*, the *polluter-pays rule* and the *ability-to-pay rule* are equivalent: According to these principles the rich (and responsible) players should compensate for the inactive rounds where they gained their wealth without contributing to climate protection. In order to equalize the players' contributions and payments the rich should contribute €20 in the active rounds, i.e. on average €3 per round. As opposed, the *sovereignty rule* does not consider the players' wealth or responsibility but rather requires the same contribution during the active rounds, i.e. €2 per round for the rich as well as for the poor players. In fact, a couple of rich subjects argued that the assignment of roles was just bad luck or good luck and that the €2 contribution per (active) round and player was a fair burden sharing. Hence, our game as much as the real climate negotiations allow for different notions of fairness. The players tend to pick the notion that is in their best interest ('self-serving bias') meaning that the implementation of that notion would generate least costs for them. This self-serving bias in the perception of

fairness has been also observed in the real climate negotiations (Lange et al. 2010) and it obviously deteriorates the chances for effective coordination.

4.5 Conclusions

The experiment presented in this chapter explores the relevance of equity and commitment issues in affecting the subjects' willingness to contribute to a public good framed in terms of avoidance of catastrophic climate change. It builds upon the game proposed by Milinski et al. (2008) to explore some further aspects that were not captured by the original design, and that are deemed important both at the theoretical and policy level. In particular the focus is on: (i) introducing asymmetries among players by means of a novel unequalizing mechanism in the first three rounds and (ii) allowing players to make non-binding pledges concerning future contributions. The extended climate change game empirically tested here captures trade-offs that are particularly salient for the issue of climate change mitigation. It is a promising tool for analyzing such tensions notwithstanding its simplicity, as it provides insights into many aspects that are crucial to climate change and coordination at large. Given the lack of scientific consensus on who should bear the burden of mitigation costs, providing empirical evidence on the driving forces behind coordination in a setting designed to mimic inequalities and bargaining possibilities faced by actors involved with climate change, should be fruitful also from a policy perspective.

The main purpose of the paper was to address the question: Will the most responsible actors contribute more to combat climate change damage in a public goods game experiment where players differ in wealth and responsibilities? The empirical answer to this question is generally 'no': Initially wealthier subjects were often unwilling to compensate for past, 'inherited', actions which had benefited them at the expense of the common good. Such resistance, much to the frustration of the remaining subjects who expected initiative on the part of the wealthy, accounted for the frequent coordination failures in the asymmetric treatments. In all twelve instances (out of twenty participating groups) where the target sum was not provided, there was an unfavourable contribution imbalance for those who had been bound to the altruistic act in the first three rounds, who ended up on average paying 60% of the bill. Not surprisingly, the

burden was shared evenly in the remaining eight successful groups, with both subgroups contributing 50% of the sum.

While neither one of the new features introduced in the climate change game alters the game structure in terms of the group trajectory required to reach the threshold for climate protection, they both have a significant impact on the groups' success rate. Asymmetries undermined coordination, especially in the treatment where subjects had no signaling mechanism beyond contributions, in which 80% of the groups failed to reach the target sum. Pledges, on the other hand, proved to be an effective lubricant of coordination, halving the percentage of failures in the treatment with endowment inequalities. Both in the baseline and across all treatments, the rate of success was 50%, a remarkably high level considering the instability of the fair share Nash equilibrium and the previous findings of 10% cooperation by Milinski et al. (2008). With respect to the latter, the higher coordination may stem from design and subject pool differences. As for the former, we argue, in accordance to much of the experimental literature, that human behavior is guided by a rich set of heuristics that may interfere with expected payoff computations, steering decisions away from the pure rationality prescriptions. Two such heuristics were discussed in Section 4.3, risk aversion and inequity aversion. The data and questionnaire analysis suggest that both play an important role in explaining the observed departures from best-response behavior.

The asymmetric geometry of global emissions introduces the possibility to argue in essentially opposite directions on the grounds of fairness motives. Developing countries may insist on the importance of past emissions to justify their unwillingness to take action, while developed countries can appeal to the relevance of current emissions, generally higher in transitioning economies, to refute to take lead in mitigation actions. These positions can be backed with different notions of equity: The *egalitarian rule*, for example, incorporates the principle of equal per capita emissions, which would demand drastic emission cuts in industrialized countries. On the other hand, the *sovereignty rule*, which postulates the principle of equal percentage reduction of current emissions, shifts more of the abatement burden to developing countries. Such asymmetries may lead to 'political lock-ins' that are detrimental to the establishment of a global agreement to curb emissions (Halsnæs and Olhoff 2005). Equity criteria might be also used by countries to influence the negotiations process in their own material self-interest. Lange et al. (2010) provide evidence that the perceived support of different equity rules by

countries is self-serving, i.e. purely tactical, and can be explained by the ranking of their economic costs. The game introduced here allows capturing relevant aspects concerning both the tension between collective good and free-riding on the efforts of others (e.g. benefiting from polluting activities without internalizing the externality), as well as the potentially disruptive role of uneven wealth and responsibilities arising from past activities.

The implications of the experimental results for the ongoing policy discussions may be important. We have seen that inequality impedes coordination. An alignment of wealth and carbon responsibilities might, on the one hand, facilitate coordination in addressing climate change. This strategy, however, is seen as dangerous as it risks unconstraint growth in emissions which might prove difficult to curb substantially in the future. The present analysis concerning the faculty to make non-binding pledges on future contributions to the public good, however, showed that this institution promotes coordination and mitigates the problems arising from the above mentioned inequalities. Future research might investigate the potential role of the 'pledge and review' mechanism in the economic catch up process in developing countries. That is, one could experimentally investigate the successfulness of a bottom-up approach based on delayed action by parties that commit to a mechanism that ensures future emission reductions.

Although necessarily simple for the sake of control and tractability, the game presented here is designed to incorporate key real-world issues, such as equity and the impact of emergent institutions based on non-binding 'pledge and review' mechanisms. One further salient aspect which is not captured by this game is that of uncertainty over the magnitude of the threshold. Future research is needed along these lines. Moreover, different games emphasizing mitigation cooperation over catastrophe avoidance coordination would complement the present analysis.

4.6 Appendix

4.6.1 Tables

Table 4.1: Experimental design

Treatment	Asymmetric players	Pledge stages	Probability of climate change	No. of subjects
Base	no	no	50%	60
Pledge	no	yes	50%	60
Base-Fair	yes	no	50%	60
Pledge-Fair	yes	yes	50%	60

Table 4.2: End payoffs given symmetric and pure strategies

Treatment type	0€/active round	2€/active round	4€/active round
Symmetric w_{all}=€34	17* (36)	20 (120)	6 (204)
Asymmetric w_{rich}=€40 w_{poor}=€28	20* 14* (36)	26 14 (120)	12 0 (204)

Note: End payoffs in € (and corresponding climate account values for the group) arising if the 3 pure strategies were adopted by all players for the 7 active rounds. The starred entries are expected values based on the 50% probability of account loss when the target sum of €120 is not reached. In the symmetric treatments (*Base* and *Pledge*), all group members begin the active play having contributed €6 in the previous 3 rounds, leaving them with a disposable endowment of €34; in the asymmetric treatments (*Base-Fair* and *Pledge-Fair*), three rich players have no prior contributions and the three poor players have prior contributions of €12, leaving them with €40 and €28 respectively.

Table 4.3: End payoffs given round-nine moves

	€0	€2	€4
€0	11* (116)	11* (118)	22 (120)
€2	10* (118)	20 (120)	20 (122)
€4	18 (120)	18 (122)	18 (124)

Note: End payoffs (and corresponding final climate account values in parentheses) to the row player given round-nine moves. Entries on or below the antidiagonal are certain, while the starred entries are expected values based on the 50% probability of account loss.

Table 4.4: A coordination game situation

	Fair	Selfish
Fair	20, 20 (120)	10*, 20* (60)
Selfish	20*, 10* (60)	20*, 20* (0)

	Fair	Selfish
Fair	20, 20 (120)	10*, 17* (78)
Selfish	17*, 10* (78)	17*, 17* (36)

	Fair	Selfish
Fair	14, 26 (120)	7*, 20* (78)
Selfish	14*, 13* (78)	14*, 20* (36)

Note: A coordination game situation: end payoffs (and corresponding final climate account values in parentheses). 'Selfish' refers to the strategy of giving €0 in each of the active rounds (10 rounds in the left matrix, 7 in the remaining two), 'Fair' to giving €2/active round. While all matrices are based on an initial endowment of €40, in the games introduced here the endowment before round 4 is either €34 for all players (centre matrix), or alternatively €28 for 'poor' row players and €40 for 'rich' column players (right matrix). Payoffs above the antidiagonal are certain, while the starred entries are expected values based on the 50% probability of account loss.

Table 4.5: OLS and tobit estimation results on contributions across treatments

VARIABLES	OLS ci1_10	Tobit ci1_10
Pledge	1.107	1.110
	(1.205)	(1.170)
Base-Fair	1.169	1.132
	(0.898)	(0.880)
Pledge-Fair	1.237	1.202
	(1.084)	(1.071)
Q2a	1.068	1.056*
	(0.639)	(0.622)
Q4a_3	-2.913***	-2.898***
	(0.838)	(0.824)
Q4a_8	-4.647***	-5.055***
	(1.398)	(1.710)
Q5a_3	-4.107***	-4.094***
	(0.747)	(0.731)
Q5a_8	-6.328***	-6.330***
	(0.855)	(0.833)
Q5a_12	4.954***	4.927***
	(1.129)	(1.104)
Q7_2	-6.686***	-6.815***
	(1.357)	(1.382)
Q7_3	-1.614***	-1.614***
	(0.546)	(0.535)
Constant	16.11***	16.16***
	(2.337)	(2.270)
Observations	240	240

OLS and tobit estimation on individual contributions; robust standard errors in parentheses (clustered at group level); significance: *** p<0.01, ** p<0.05, * p<0.1.
Definitions of variables:
ci1_10 = average contribution of player i over all rounds,
Base = 1 if player in treatment *Base*, 0 otherwise,
Pledge = 1 if player in treatment *Pledge*, 0 otherwise,
Base-Fair = 1 if player in treatment *Base-Fair*, 0 otherwise,
Pledge-Fair = 1 if player in treatment *Pledge-Fair*, 0 otherwise,
Q2a = answer to the question which is the fair contribution/active round of the rich (possible answers: 0, 1, 2, 3, 4),
Q4a_3 = 1 if motivation for contribution decision is self-interest, 0 otherwise,
Q4a_8 = 1 if motivation for contribution decision is belief that 120 would not be reached (abandon the ship),
Q5a_3 = 1 if motivation for final round contribution decision is self-interest, 0 otherwise,
Q5a_8 = 1 if motivation for final round contribution decision is belief that 120 would not be reached (abandon the ship),
Q5a_12 = 1 if motivation for final round decision is compensation for others,
Q7_2 = 1 if risk seeker, 0 otherwise,
Q7_3 =1 if risk neutral, 0 otherwise.

Table 4.6: Probit estimation results on success across treatments

VARIABLES	(1) Success	(2) Success	(3) Success	(4) Success
Base	-0.100	0.320	-0.205	
	(0.224)	(0.211)	(0.218)	
Pledge	0.108	0.483***		0.205
	(0.230)	(0.174)		(0.220)
Base-Fair	-0.400**		-0.479***	-0.318
	(0.187)		(0.168)	(0.206)
Pledge-Fair		0.404**	-0.107	0.101
		(0.194)	(0.229)	(0.224)
Observations	240	240	240	240

Numbers are marginal effects at the mean of the independent variable;
Robust standard errors in parentheses (clustered at group level);
Significance: *** p<0.01, ** p<0.05, * p<0.1.
Definitions of variables (see also Table 4.5):
Success = 1 if individual's group reached the €120 threshold, 0 otherwise.

Table 4.7: Probit estimation results on success across treatments with pledges

VARIABLES	Success
Pledge-Fair	-0.244
	(0.197)
Diffpledge1	-0.0397***
	(0.0129)
Diffpledge2	-0.0629**
	(0.0299)
Observations	120

Numbers are marginal effects at the mean of the independent variables;
Robust standard errors in parentheses (clustered at group level);
Significance: *** p<0.01, ** p<0.05, * p<0.1.
Definitions of variables (see also Tables 4.5 and 4.6):
Diffpledge1 = difference between individual contribution and pledge in rounds 4-10,
Diffpledge2 = difference between individual contribution and pledge in rounds 8-10.

Table 4.8: Questionnaire and responses – Part I

Question		Answer	No.	%
(1) Do you agree with the following statement? "Those who began in round 4 with a starting capital of EUR 40 should pay more into the climate account in the following seven rounds than the other players."		Agree	91	75.83
		Disagree	12	10.00
		Neither	17	14.17
(2) Please assume that three players of a group begin in round 4 with a starting capital of EUR 40 (because they have not paid anything into the climate account yet) whereas the other three players begin with a starting capital of EUR 28 (because they have paid EUR 4 into the climate account in each of the first three rounds).	What would you consider a fair average investment for the following seven rounds for those beginning with EUR 40?	0	2	0.83
		1	2	0.83
		2	30	12.50
		3	190	79.17
		4	16	6.67
	What would you consider a fair investment for the following seven rounds for those beginning with EUR 28?	0	9	3.75
		1	143	59.58
		2	85	35.42
		3	3	1.25
		4	0	0.00
(3) Please try to remember the decisions made by your fellow players during the game. In your opinion, which players have been motivated by following reasons? Please write one or more names next to each motive. Do you think there were any other motives for your fellow players besides the given? Possible motives are - Monetary self-interest - Fairness consideration - Advancement of the common coordination process - Other motives (please specify and state name)				
(4) Please briefly describe the three most important reasons for your investment decisions in a descending order of importance. Possible examples are: - Group or own investments in the *preliminary round,* - Cumulated group or own investments starting in *round 4,* - Cumulated group or own investments starting in *round 1,* - Monetary self-interest, - Fairness consideration, - Achievement of the EUR 120 limit, - Adherence to declarations of intent, - Other reasons (please state).				
(5) What has been your motivation for your investment decision in the last round (round 10)? Please state your three most important reasons in a descending order of importance (for possible answers see previous question)				
(6) If you were to play the game again, would you make different decisions? Please state your three most significant changes in a descending order of importance.				
		∑	240	100.00

Notes: Question 1 was asked in the asymmetric treatments *Base-Fair* and *Pledge-Fair* only. Question 2 was asked in all treatments; therefore it was hypothetical in the symmetric treatments *Base* and *Pledge* while it was real in the asymmetric treatments. No responses are provided for the open questions 3-6.

Table 4.9: Questionnaire and responses – Part II

Question	Answer	No.	%
(7) Please imagine the following situation: You have EUR 40. With a probability of 50 % you will lose all EUR 40. You could abide the risk by giving away EUR 20 of the EUR 40. Would you pay EUR 20 to avoid the risk?	Yes	165	68.75
	No	22	9.17
	Indifferent	53	22.08
(8) Did you ever donate money of goods to a charity organisation?	Often	14	5.83
	Sometimes	77	32.08
	Rarely	102	42.50
	Never	47	19.58
(9) Do you agree with this statement? "I think social differences should be levelled out more in Germany."	Agree	110	45.83
	Disagree	47	19.58
	Neither	83	34.58
(10) Do you think the problem of global climate change is being estimated correctly or not? In my opinion, the problem is being	Rather overestimated	51	21.25
	Rather correctly estimated	83	34.58
	Rather underestimated	89	37.08
	I don't know	17	7.08
(11) In your opinion which challenges in Germany are currently the greatest? Please state the three greatest challenges in a descending order of importance.	Old age provisions	18	7.50
	Unemployment	48	20.00
	Poverty	6	2.50
	Educational policy	66	27.50
	Energy supply	3	1.25
	Health care	3	1.25
	Climate protection	13	5.42
	Crime	1	0.42
	Social security	4	1.67
	Fiscal policy	6	2.50
	Terrorism	0	0.00
	Environmental protection	3	1.25
	Economic upturn	40	16.67
	Immigration/Integration	7	2.92
	Other (please state below)	22	9.17
(12) Which of the following guiding principles describes your understanding of fairness best in the context of international climate negotiations?	Countries with high emissions in the past should reduce more emissions.	56	23.33
	Countries with high economic performance should reduce more emissions.	53	22.08
	Countries should reduce their emissions in such a way that emissions per capita are the same for all countries.	41	17.08
	Countries should reduce their emissions in such a way that the emissions percentage is the same for all countries.	53	22.08
	Other principle (please specify)	37	15.37
(13) What are the reasons for your answer in the previous question? Please state the three most important reasons in a descending order of importance.			
	∑	240	100.00

Notes: The responses to question 11 refer to the first of the three greatest challenges. No responses are provided for the open question 13.

4.6.2 Figures

Figure 4.1: Success rate by treatment

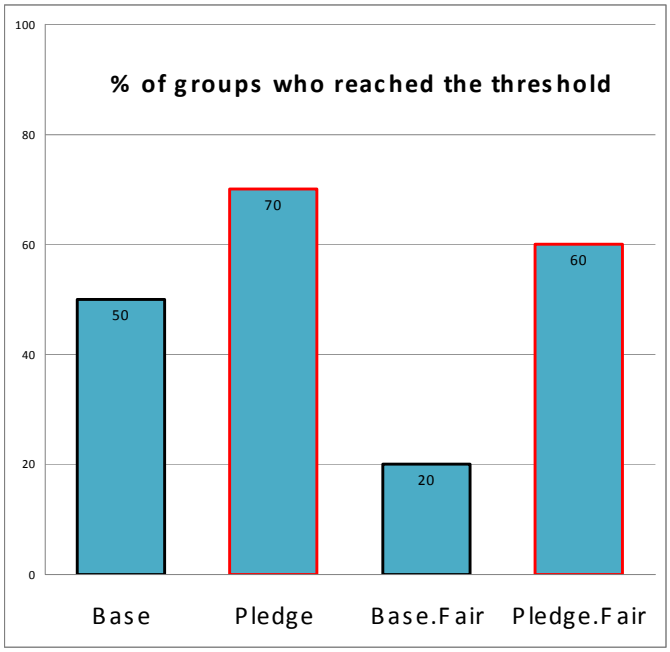
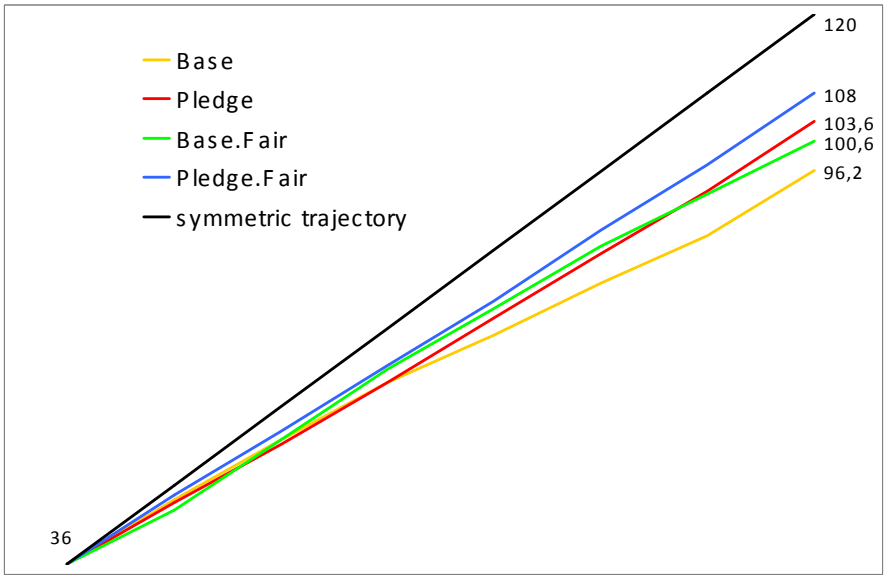
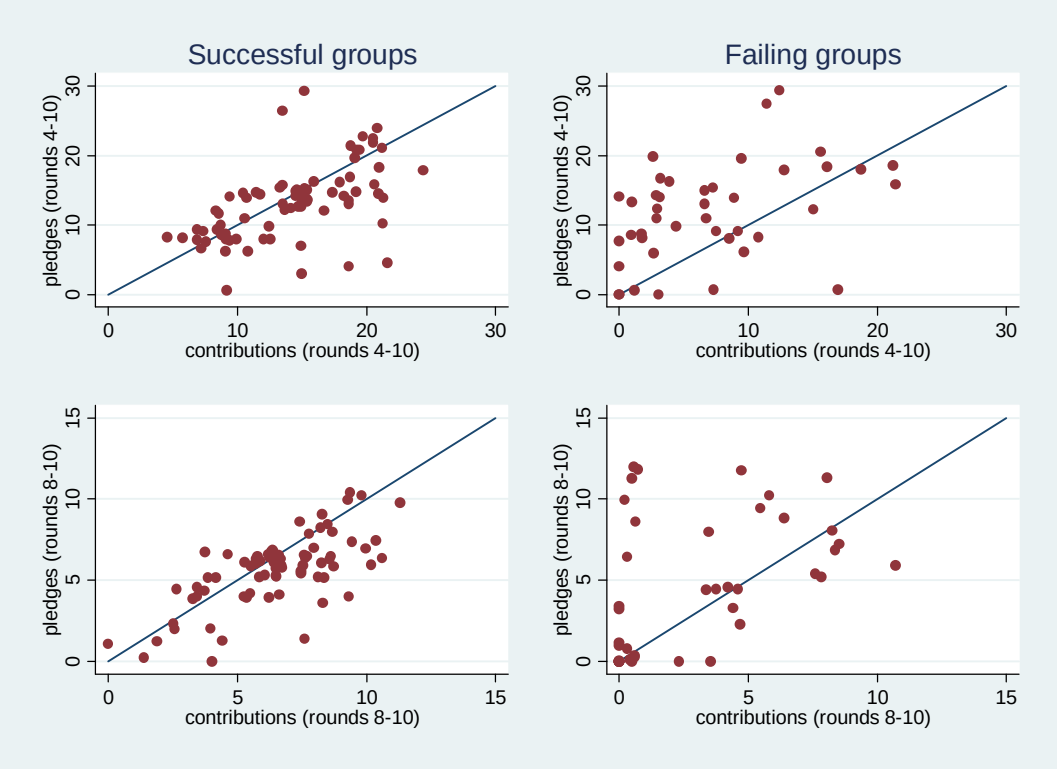


Figure 4.2: Contribution patterns in each treatment



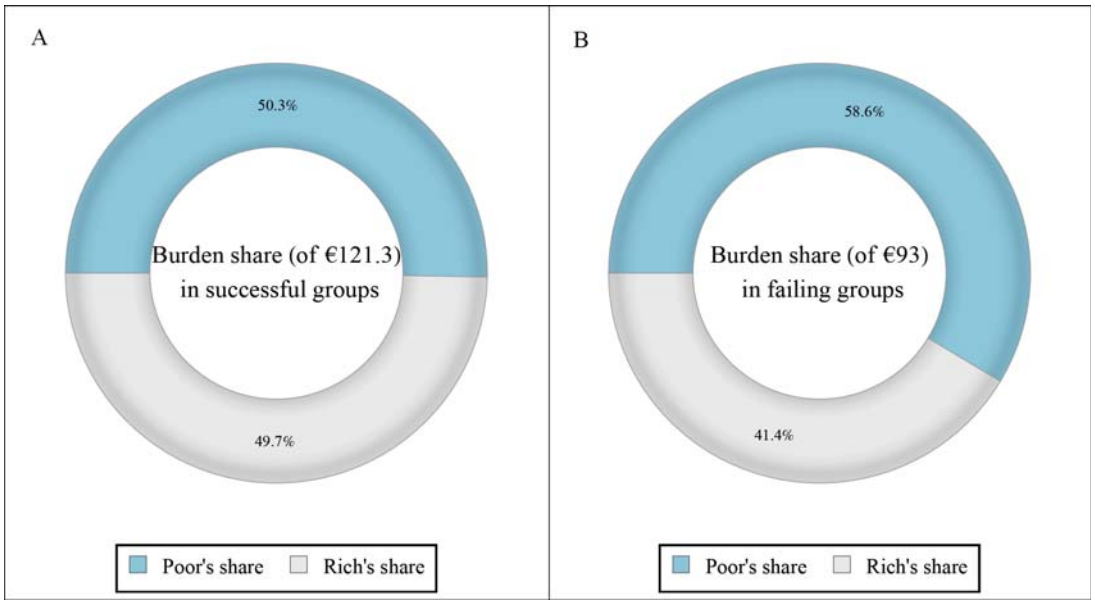
Note: Contribution patterns in each treatment, starting with round 3.

Figure 4.3: Use of pledges in successful groups and failing groups



Note: The graphs show individual pledges on the vertical axis and individual contributions on the horizontal axis. A small noise (5%) is inserted to make all observations visible.

Figure 4.4: Burden sharing in successful groups and failing groups



Note: In successful groups partaking in the treatments with unequal endowments (*Base-Fair* and *Pledge-Fair*), the rich compensated the poor by investing more in the active rounds and equalizing cumulative contributions over the entire game at €20 (A). In failing groups such wealth redistribution did not take place to the same extent: The initial gap of €12 between the rich and poor was not fully offset, as the rich invested €13 on average while the poor invested €18 (B).

4.6.3 Experimental instructions

Experimental instructions for the treatments *Pledge* and *Pledge-Fair*

Welcome to the experiment!

1. General Notice

In this experiment you can earn money. To make this experiment a success, please do not talk to the other participants at all or draw any other attention to you. Please read the following rules of the experiment attentively. Should you have any questions please signal us. At the end of the instructions you will find several control questions. Please answer all questions and signal us when you have finished. We will then come to you and check your answers.

2. Climate Change

Now we will introduce you to a game simulating climate change. Global climate change is seen as a serious environmental problem faced by mankind. The great majority of climate scientists expect the global average temperature to rise by 1.1 to 6.4 degrees Celsius until the year 2100. There is hardly any denial that mankind largely contributes to climate change by emitting greenhouse gases, especially carbon dioxide (CO_2). CO_2 originates from burning of fossil fuels like coal, oil or natural gas in industrial processes and energy production, or combustion engines of cars and lorries. CO_2 is a global

pollutant, i.e. each quantity unit of CO_2 emitted has the same effect on the climate regardless of the location where the emission has occurred.

3. Rules of Play

In total, **6 players** are involved in the game, so besides you there are 5 other players. Every player faces the same decision making problem. At the beginning of the experiment you will receive a starting capital (= **EUR 40**) credited to your private account. During the experiment you can use money from your account or not. In the end your account balance will be paid out to you in cash. You will be making your decisions anonymously. To guarantee for this you will be assigned a nickname for the playing time. The nicknames are the moons of our solar system (Ananke, Telesto, Despina, Japetus, Kallisto or Metis). You will find your name on the lower left side of your screen.

During the course of the experiment you will be playing exactly **10 climate rounds**. In these rounds you can invest into the attempt to protect the climate and to evade dangerous climate change. Among others, dangerous climate change will result in significant economic losses which will be simulated in this experiment. In each climate round of the game all six players will be asked **simultaneously**:

"How much do you want to invest into climate protection?"

Possible answers are EUR 0, 2 or 4. Only when each player has made his choice, all decisions will be displayed simultaneously. After that the computer will credit all invested amounts to an account for climate protection (‘climate account’).

At the end of the game (after exactly 10 rounds) the computer will compare the climate account balance with a predetermined amount (= **EUR 120**). This amount must be earned to evade dangerous climate change. It will be earned if **every** player **averagely** pays **EUR 2 per round** into climate protection. If this is the case, EUR 12 are be paid into the climate account per round. If the necessary EUR 120 have been earned, all players will be paid out the amount remaining on their private accounts. The remaining amount consists of the starting capital of EUR 40 minus the sum paid into the climate account. If the necessary EUR 120 have **not** been earned, dangerous climate change will occur with a probability of **50%** (in 5 out of 10 cases) and this will result in significant economic losses. If this probability arises you will lose all money left on your account and no one will be paid out anything. With another probability of **50%** (in 5 out of 10 cases) you will keep your money and will be paid out the amount on your private account after the game. We will draw the probability by lot in your presence. The payout will be made anonymously. Your fellow players will not learn about your identity.

Please note the following two particularities in the game: First, the decisions of the six players in the first **three rounds** are **predetermined** by the computer. Meaning, you - and your fellow players - **cannot** decide freely how much you want to invest into climate protection in the first three rounds. You will be offered an option instead which you have to choose. Please note that the predetermined investments of the first three rounds will already change the amounts on the climate account and the players’ accounts! Starting in round 4 you will decide freely which amounts you want to invest into climate protection.

Second, all players can issue **declarations of intent** about how much they want to invest into climate protection in the following rounds. The declarations are **not** binding

for the investment decisions in the following rounds. The first declaration of intent is issued after round 3. All players will simultaneously state how much they plan to invest into climate protection in the next seven rounds in total. When all players have stated their declarations of intent, the **'planned climate account'** will be displayed. The planned climate account shows the investments of each player of the first 3 rounds **plus** the investments **planned** for the remaining seven rounds. After round 7 all players will be given the opportunity to revise their declarations of intent. All players then simultaneously state their planned total investments into climate protection for the next **three rounds**. When all players have stated their declarations of intent the **'newly planned climate account'** will be displayed. The newly planned climate account shows how much each player has already invested in the first seven rounds **plus** the **planned** investments for the remaining three rounds.

4. Example

In this example you see the decisions made by the six players in one round (round 6).

geplantes Klimakonto Runden 1-10		Investitionen Runden 1-6 insgesamt		Investitionen Runde 6	
Ananke	20	Ananke	12	Ananke	0
Telesto	18	Telesto	12	Telesto	0
Despina	22	Despina	14	Despina	0
Japetus	18	Japetus	10	Japetus	4
Kallisto	20	Kallisto	12	Kallisto	4
Metis	14	Metis	8	Metis	4
Gruppensumme	112	Klimakonto insgesamt	68	Gruppensumme Runde 6	12

The column on the right side ("Investitionen Runde 6") shows the investments made in the current round. Players Ananke, Telesto and Despina have not paid anything into the climate account, whereas players Japetus, Kallisto and Metis each have paid EUR 4. In total EUR 12 have been paid and by that been credited to the climate account. The column in the middle ("Investitionen Runden 1-6 insgesamt") shows the total investments made by each player in rounds 1-6. Players Ananke, Telesto and Kallisto each have paid EUR 12 into the climate account in the first 6 rounds. Despina has paid EUR 14, Japetus EUR 10 and Metis EUR 8 in the first six rounds. By that a total of EUR 68 has been paid into the climate account.

The column on the left ("geplantes Klimakonto Runden 1-10") shows the planned climate account after the **first** declaration of intent. The value stated per player shows the investments made in the first three rounds **plus** the planned investments for the remaining seven rounds. Exactly this information will be displayed after each climate round.

5. Usage of the Money on the Climate Account

If the necessary EUR 120 have been earned to evade climate change, we will buy CO_2 emission certificates of the **total amount** on the climate account and retire them. If the necessary EUR 120 have **not** been earned, we will use **half** of the amount on the climate account to buy CO_2 emission certificates and retire them (we will keep the rest of the money). By purchasing and retiring the CO_2 emission certificates we contribute to the **abatement of climate change**. We will now explain you how this works:

In 2005 the European Union has implemented the emissions trading system for carbon dioxide (CO_2). Emissions trading is the central instrument of climate policy in Europe. It follows a simple principle: The European Commission, together with the member states, has determined the amount of CO_2 to be emitted altogether in the respective sectors (energy production and energy intensive industries) until 2020. This total amount will be distributed to the companies by the state in the form of emission rights ('certificates'). For each quantity unit of CO_2 emitted, the company has to give a certificate to the state. The certificates can be traded between companies.

For each quantity unit of CO_2 emitted e.g. by a power plant, the plant operator has to prove his permission to do so in the form of a certificate. This leads to an important consequence: If the total amount of certificates is reduced, the total emissions will be lower, simply because plant operators do not possess enough emission allowances. That means if a certificate for one quantity unit is obtained from the market and is being 'retired' (i.e. deleted) the total CO_2emissions are reduced by exactly this quantity amount. The opportunity to retire certificates actually exists in the framework of the EU Emissions Trading System. In Germany the German Emissions Trading Authority (DEHSt) regulates Emissions trading. The authority holds a retirement account with the account number DE-230-17-1.

If certificates are transferred to this account they will be withdrawn from circulation, i.e. deleted, by the end of each year. ZEW has opened an own account at the DEHSt (DE-121-2810-0). The purchasing and retiring of the certificates will furthermore be **attested by a notary public.**

Summarizing: if all players have for example paid a total of EUR 120 into the climate account, we will buy certificates for about 8 tons of CO2 (the price per ton is currently at about EUR 15). This equals the emissions of a ride in a VW Golf (1.4 TSI) one and a half times around the world.

6. Control questions

If you have finished reading the instructions and do not have questions, please answer the following control questions.

a. Which total amount does each player have to *averagely* invest into climate protection in the 10 rounds to evade dangerous climate change (please tick the according box)?

   O EUR 12 O EUR 20 O EUR 40 O EUR 120

b. Please assume that the necessary amount of EUR 120 to evade climate change has been earned and you have invested a total of EUR 16 in the 10 rounds. How much money will you be paid out?

   My payout is EUR _____.

c. In how many rounds can the players decide freely about their investments into climate protection (please tick the according box)?

O in 3 rounds O in 5 rounds O in 7 rounds O in 10 rounds

d. Please refer to the example stated under point 4 for the numbers. What do the balances on Despina's and Metis' private accounts state?

Despina's balance states EUR _____. Metis' balances states EUR _____.

e. Please refer to the example under point 4 again. How much would the *group* have to pay into the climate account in the next four rounds *in total* to abate dangerous climate change (please tick the according box)?

O EUR 12 O EUR 52 O EUR 68 O EUR 120

f. When do the players state their first declaration of intent and when can they revise this declaration?

First declaration after round: _____. Revision after round: _____.

g. In your first declaration of intent after round 3 you are asked to state how much you want to invest in climate protection in the following seven rounds *in total*. If you want to invest averagely EUR 2 per round, which amount would you have to state in your declaration of intent (please tick the according box)?

O EUR 2 O EUR 12 O EUR 14 O EUR 20

h. Are the declarations of intent binding for the investment decisions in the following rounds (please tick the according box)?

O Yes O No

i. Please refer to the example under point 4 again. What do the figures in the left column 'Planned climate account' stand for (please tick the according box)?

O the invested amounts of the first three rounds

O the planned investments for the last seven rounds

O the invested amounts of the first three rounds *plus* the planned investments for the last seven rounds

j. Please refer to the example stated under point 3 for the numbers again. Please assume that all players adhere to their declaration of intent (see 'geplantes Klimakonto'). Would the investments be enough to evade dangerous climate change (please tick the according box)?

O Yes O No

k. Please assume that the necessary amount of EUR 120 has not been earned. With which probability will you lose the remaining amount on your private account (please tick the according box)?

O 10% O 30% O 50% O 70% O 90% O 100%

If you have answered all control questions, please signal us. We will come to you and check the answers. After having checked the answers of all players and there are no remaining questions, the game starts. Good Luck!

Part II

Other-regarding preferences

5 The social preferences of climate negotiators

5.1 Introduction

In reaching an agreement in climate negotiations the overall abatement target and with this total implementation costs of a climate treaty have always played an important role. All the same, there is also evidence that climate talks are, to a great extent, centered around the question of how to share a given abatement burden. The 1992 Climate Change Convention already states the basic principle of "common but differentiated responsibilities" (UNFCCC 1992), and numerous other negotiation documents are permeated by the language of equity. The experiment presented in the previous chapter clearly shows that a common fairness notion is decisive for the coordination of efforts to provide a public good. The lack of agreement about the fair burden sharing often causes coordination failure and therefore a collective damage. The impression that equity considerations also play a major role in real-world climate negotiations is supported by a recent survey (Lange et al. 2007) asking participants in the climate negotiation process about their views on equity. Nearly 80 percent of all respondents state that equity is of very high or high importance in the climate talks. Moreover, this survey identifies important fairness principles that motivate negotiating positions of major negotiation blocks. The EU, for example, is mainly seen as being driven by the *polluter-pays principle* while many respondents associate the United States with the *sovereignty rule*.[24]

Essentially, this evidence may be interpreted in two different ways. First, it could mean that equity principles enter climate negotiations because they reflect deep and serious convictions of the parties involved. Second, one might conjecture that equity arguments are used strategically in order to hide goals which may largely be traced back to pure material self-interest. Lange et al. (2010), for example, argue that negotiation parties may invoke fairness principles to influence the bargaining outcome in their interest. The

[24] Not only the political but also the academic debate is concerned with equity issues. Several papers explore the equitable burden sharing of a given reduction target, e.g. Bosello and Roson (2002), LeCocq et al. (2000), Ridgley (1996), Rose and Stevens (1993), and Rose et al. (1998). A second branch of the literature tries to find reduction measures that maximize human welfare, e.g. Nordhaus and Yang (1996) Peck and Teisberg (1991, 1995), and Tol (1999). A third approach combines equity rules, permit allocation schemes and coalition stability, e.g. Bosello et al. (2003) and Altamirano-Cabrera and Finus (2006). As Kemfert and Tol (2002, p. 24) note, however, these attempts "are based on a narrow neo-classical interpretation of justice", i.e. they do not include a preference for equity in the utility function.

previous chapter also provides some empirical evidence of the existence of a self-serving use of fairness notions.

Contrary to the latter argument, there is much evidence that human behavior is indeed to a certain extent driven by equity considerations. Within experimental economics, ample evidence has been collected contradicting the standard economic model of man based on the two pillars of rationality and pure selfishness. People cooperate in social dilemmas such as public good games (Ledyard 1995), they reject large amounts of money in the ultimatum game (Güth et al. 1982, Camerer 2003) and they make positive contributions in the dictator game (Kahneman et al. 1986, Forsythe et al. 1994). The contradiction between the standard economic model of selfish behavior and empirical observations has been a challenge for both theorists and experimentalists. In the past years a number of theories that try to close this gap in explanatory power has been developed. Most of these theories are based on the assumption that people have some sort of other-regarding, or social, preferences. These approaches seek to overcome the discrepancies between standard game-theoretical prediction and experimental observation by altering the underlying utility function of subjects, but adhere to the assumption that subjects behave rationally. The models developed by Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) are prominent examples of this approach. They assume that people suffer from inequality, i.e. they are willing to sacrifice money in order to avoid unequal payoff distributions.

These theoretical approaches have the potential to greatly facilitate the explanation for voluntary cooperation in dilemma situations. Fehr and Schmidt (1999) (in the following F&S) prove that partial cooperation may be an Nash equilibrium in a public good game if at least some subjects show a sufficiently strong inequality aversion. Within the framework of a two-stage coalition formation game, Lange and Vogt (2003) prove that coalitions which involve a rather large fraction of countries may be stabilized as an Nash equilibrium when a sufficient number of countries with a sufficiently high inequality aversion is involved. This result is in sharp contrast to the corresponding results of coalition games which assume a standard preference structure. In these games, only small coalitions that achieve very little in terms of pollution abatement and welfare can be stabilized (Barrett 1994, Carraro and Siniscalco 1993). The cooperation enhancing effect of equity preferences might also be of practical relevance to real-world

climate policy. However, whether the critical conditions for cooperative behavior are fulfilled is a question which may only be answered empirically.[25]

If the chances to come to an agreement depend on the degree of inequality aversion, this should be taken into account in real-world cooperation problems. International climate negotiations involve teams of negotiators who, on the one hand, must work on the basis of the political realities of their home countries and, on the other hand, set the agenda for the negotiation process and influence the public dispute. In the process, the individual preferences of negotiators affect the outcome of negotiations. A priori it is not clear whether real-world negotiators have differing preferences for equity. Additionally, the issue of how negotiators' individual equity preferences relate to the corresponding collective preferences of governments (or countries) must be considered.

The innovative contribution of the experiment in this chapter consists in making a first attempt at the elicitation and quantification of such equity concerns and suggesting a simple way to include equity preferences in the global climate policy context. To this end an online experiment was conducted with individuals who had been involved in international climate policy. 155 participants from all regions of the world took part in the experiment that basically consisted of two simple non-strategic games suited to measure individual inequality aversion. Thereby one can distinguish between two types of inequality aversion: If an individual dislikes being better off than others this is called 'aversion to advantageous inequality'. If an individual suffers from being worse off than others we call this 'aversion to disadvantageous inequality'. The participants of the experiment show aversion to advantageous inequality to a considerable extent while their aversion to disadvantageous inequality is moderate. Regarding the geographical variety in the data, the degrees of inequality aversion are rather similar across different regions of the world. This also applies to the expected collective preferences. Therefore, different positions in international climate policy seem to be caused by national interests rather than by different equity preferences.

[25] Several experiments test the empirical relevance of the F&S theory in the lab (e.g. Blanco et al. forthcoming, Brosig et al. 2007, Dannenberg et al. 2007). The evidence is rather mixed but the general impression is that the individual behavior across games is not reliably consistent with F&S. However, the measurement of social preferences in the lab involves some difficulties which is the object of Chapter 7.

This chapter proceeds as follows: Section 5.2 briefly explains the theoretical background underlying the experiment. Section 5.3 describes the experimental design, followed by a short description of the subject pool in Section 5.4. Section 5.5 presents the results and Section 5.6 concludes.

5.2 Theoretical background

5.2.1 Preferences: the model of Fehr and Schmidt (1999)

According to F&S individuals are not exclusively motivated by the absolute payoff they may earn but also value allocations due to their distributional consequences. Particularly, assuming that individuals suffer from inequality, F&S introduce the following utility function for subject i:

$$U_i(\pi_i,\pi_j)=\pi_i-\alpha_i\frac{1}{n-1}\sum_{j\neq i}^{n}\max\{\pi_j-\pi_i,0\}-\beta_i\frac{1}{n-1}\sum_{j\neq i}^{n}\max\{\pi_i-\pi_j,0\} \qquad (5.1)$$

where π_i and π_j denote the absolute payoffs to subjects i and j, respectively, n denotes the total number of players involved in a decision problem, $\alpha_i \geq 0$ measures the impact of i's disutility from disadvantageous inequality while $\beta_i \geq 0$ measures the corresponding impact of advantageous inequality. F&S assume $\beta_i < 1$, i.e. players are not willing to 'burn' their money in order to eliminate advantageous inequality. In addition, they assume that players put a greater weight on disadvantageous inequality, i.e. $\alpha_i \geq \beta_i$.

5.2.2 The voluntary contribution game

The voluntary contribution game as a special form of a public good game[26] represents the basic strategic incentives of a situation where $n \geq 2$ players have the chance to contribute to the production of a global public good, such as climate protection. Let y_i denote the initial endowment of player i, $g_i \in [0, y_i]$ his or her contribution to the

[26] Sturm and Weimann (2006) discuss the relevance of this game to experiments in environmental economics.

public good, and m the marginal per capita return (MPCR) of an investment to the public good with $1/n < m < 1$. Then, player *i*'s payoff is derived as

$$\pi_i = y_i - g_i + m\sum_{j=1}^{n} g_j \,. \qquad (5.2)$$

Assuming standard preferences in a voluntary contribution game, not to contribute to the production of the public good is the Nash equilibrium in dominant strategies, although from a social point of view mutual cooperation would be preferable. In other words, $g_i = 0$ is the best choice for each player *i* independently of the other players' contributions.

F&S have shown that this result is fundamentally altered if players are endowed with inequality aversion according to (5.1). They prove the following results:

1. If $m + \beta_i < 1$, then it is a dominant strategy for player i to choose $g_i = 0$.
2. Let *k,* with $0 \le k \le n$, denote the number of players with $m + \beta_i < 1$. Then, if $k/(n-1) \ge m/2$, a unique equilibrium with $g_i = 0 \;\forall i \in \{1,...,n\}$ exists.
3. If for all players $j \in \{1,...,n\}$ with $m + \beta_j > 1$ the condition

$$k/(n-1) < (m + \beta_j - 1)/(\alpha_j + \beta_j) \qquad (5.3)$$

holds, then equilibria with positive contributions to the public good exist. All *k* players with $m + \beta_i < 1$ choose $g_i = 0$ while all other players contribute $g_j = g \in [0, y]$.

The intuition behind these results is not too difficult. First, if a player with $m + \beta_i < 1$ invests one monetary unit in the public good, his monetary return is m while he gains a maximum non-monetary utility of β_i. Now, if the sum of both returns is less than one, the best strategy is evidently not to invest in the public good, irrespectively of what other players do. Second, if there is a sufficient number of players with $m + \beta_j < 1$, then player j will not be willing to contribute even if he shows stronger inequality aversion, i.e. for him $m + \beta_j > 1$ holds. The reason is that relatively few 'fair' players are unable to sufficiently reduce disadvantageous inequality. Third, if there is a sufficient number of players with $m + \beta_j > 1$, they are able to sustain cooperation amongst themselves, "even if the other players do not contribute. However, this requires that the contributors

are not too upset about the disadvantageous inequality toward the free riders" (Fehr and Schmidt 1999, p. 840).

In the following, condition (5.3) is used to discuss the meaning of α_j and β_j for the prospects of cooperation explicitly. Let us define $k_{crit} := (n-1)(m+\beta_j-1)/(\alpha_j+\beta_j)$, the critical number of non-cooperative countries. First, it is to observe that $\partial k_{crit}/\partial \beta_j = (n-1)(\alpha_j+1-m)/(\alpha_j+\beta_j)^2$ which is positive since the MPCR is always less than 1. Hence, an increasing aversion to advantageous inequality makes cooperation in the voluntary contribution game more likely since (5.3) is more easily met. Second, considering α_j we find $\partial k_{crit}/\partial \alpha_j = (n-1)(1-m-\beta_j)/(\alpha_j+\beta_j)^2$. For subjects with $m+\beta_j > 1$ this derivative will clearly be negative implying that an increasing aversion to disadvantageous inequality makes it more difficult to sustain cooperation amongst 'fair' subjects.[27]

To summarize, while stronger aversion to advantageous inequality always improves the prospects for a cooperative solution this is not the case for aversion to disadvantageous inequality. However, for a given value of α_j, high values of β_j are only necessary but not sufficient to ensure stable cooperative outcomes. To attain such a socially preferable outcome, i.e. to exceed the critical value k_{crit} of non-cooperative countries, the benefit-to-cost ratio of the contribution to the public good has to be sufficiently high.

5.3 Experimental design

The experiment involves two simple non-strategic games (games A and B) introduced by Blanco et al. (forthcoming) suited to measure individual inequality aversion as captured by the F&S model. Both games were neutrally framed as two-person games of sharing a pie (see Section 5.7.3 for experimental instructions). Game A is designed to measure subjects' aversion to disadvantageous inequality, namely α_j. The game

[27] The parameter α_i has additional importance for a public good game with a chance to punish other subjects at one's own expense. In such a game, subjects with a sufficiently high α_i may enforce cooperation of selfishly motivated subjects. The reason for this is that such 'enforcers' are able to exercise a credible threat to punish free riders in order to reduce disadvantageous inequality. See Fehr and Schmidt (1999) as well as Dannenberg et al. (2007).

resembles the responder's basic decision situation in the ultimatum game but abstracts from strategic interaction, so that it rules out individual behavior caused by strategic considerations such as intentions or reciprocity.[28] This game consists of 22 decisions (numbered from #1 to #22), in which each subject in the role of Person 1 has to choose between two pairs of payoffs (pair I and pair II), each with an amount of money for him- or herself and another subject (Person 2). Except for #1 subjects always have to choose between pair I, a disadvantageously unequal division of $200.00, and pair II, an equal distribution with $40.00 for both players (see the left part of Table 5.1). All decisions are arranged by the amount of money subjects could earn with pair I in descending order. In this game, a rational and purely selfish subject is expected to choose pair I from #1 to #20 and pair II for #21 and #22. Subjects with F&S preferences are expected to switch from pair I to pair II at some point between #2 and #21.

Individual behavior in game A is described as consistent if (1) a subject has a unique switching point from pair I to pair II and (2) this switching point is between #2 and #21. Regarding the first condition, a subject with aversion to disadvantageous inequality consistent with the F&S model who switches at some point from pair I to pair II should in all subsequent decisions choose pair II. As the payoffs for Person 1 in pair I are arranged in descending order, a switch back to pair I in any of the subsequent decisions is not consistent. This would lead to a lower payment for Person 1 and to higher disadvantageous inequality than the payoff that was rejected before. In relation to the second condition, it is useful to consider the decisions outside of the 'consistent area' between #2 and #21. A subject who chooses pair II already in #1 is not regarded as consistent because he or she could attain an equal allocation with higher payoff for him- or herself by choosing pair I. A subject who chooses pair II in #22 is in favor of disadvantageous inequality, i.e. $\alpha_i < 0$, and is therefore not consistent with the F&S model. The subject's switching point determines the upper and lower bounds of the individual α_i. The individual value for α_i is approximated by choosing the mean of the corresponding interval (see Table 5.1).[29]

[28] The difference to the payoffs in the original ultimatum game is the fact that the conflict point payoffs (in $) are changed to (40, 40) instead of the original (0, 0).

[29] There are two exceptions to this rule. Firstly, there is no upper bound for α_i of a subject who switches from pair I to pair II in #2. Therefore, the value of the lower bound, $\alpha_i = 2.18$, is assigned to these

Game B – which resembles the decision problem in the dictator game – is designed to measure subjects' aversion to advantageous inequality, namely β_j.[30] Again, there are 22 decisions (from #1 to #22; see the right part of Table 5.1) in which each subject in the role of Person 1 has to choose between two pairs of payoffs (pair I and pair II), each with an amount of money for him- or herself and another subject (Person 2). Subjects have to choose between pair I, an extremely unequal but advantageous distribution of \$200.00, and pair II, an equal distribution of different amounts ranging from \$0.00 to \$210.00 for each player. In this game, a rational and purely selfish subject would choose pair I from #1 through #20 and pair II for #22. In #21, this subject would be indifferent between pair I and pair II. Subjects with F&S preferences are expected to switch from choosing pair I to pair II between #2 and #22.

Individual behavior in game B is labeled as consistent if (1) a subject has a unique switching point from pair I to pair II and (2) this switching point is between #2 and #22., i.e. if the aversion to advantageous inequality meets $0 \leq \beta_i < 1$. Relating to the first condition, a subject with aversion to advantageous inequality consistent with the F&S model switching from pair I to pair II at one point, should also choose pair II in all subsequent decisions. As the payoffs for Person 1 are arranged in an ascending order in pair II, a switch back to pair I in any of the subsequent decisions is not consistent. This would lead to the same advantageous inequality that was rejected before but now with the higher opportunity costs of a lost payoff. For the second condition, consider again the decisions outside of the 'consistent area' between #2 and #22. A subject choosing pair II already in #1 has $\beta_i \geq 1$, i.e. is willing to 'burn' money in order to produce equal payoffs. A subject who does not switch at all displays affection for advantageous inequality, i.e. $\beta_i < 0$. Both behavioral patterns are not consistent with F&S. As before, the subject's switching point determines the upper and lower bounds for the individual's β_i. The individual value of β_i is approximated by choosing the mean of the

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subjects. Secondly, $\alpha_i = 0$ is assigned to a subject who switches from pair I to pair II in #21, although the corresponding interval for this case is $-0.08 \leq \alpha_i \leq 0.04$.

[30] Strictly speaking, game B is equivalent to a reduced form of the dictator game only in decision #11. However, similar to the dictator game, game B creates a trade-off between a subject's own monetary payoff which creates advantageous inequality and a lower but equally distributed payoff.

corresponding interval (see Table 5.1).[31] The above described consistency rules are relatively strict. However, applying these strict rules helped to exclude subjects who had not fully understood the rules of the experiment and those who did not care about their payoff but rather made random choices.

A basic assumption underlying the design of the two games is that individuals are only driven by equity preferences. There is, however, an alternative interpretation of non-selfish behavior in these games since the parameters α_i and β_i are inevitably linked to efficiency concerns. An example will help to illustrate this point: In game B, the sum of both payoffs in pair II rises from \$0 in #1 to \$420 in #22. An individual caring for efficiency only will switch from pair I to pair II after #10 or #11. In other words the aversion to advantageous inequality measured by β_i may also be interpreted as a preference for efficiency (here with $\beta_i < 0.53$). In the experiment 30 % of subjects have $\beta_i < 0.53$ and thereby may care for equity or efficiency only or a mixture of both motives. It is not possible to distinguish between the underlying motives of behavior, i.e. there are no unbiased 'efficiency free' α_i and β_i values.[32] However, the implications for the willingness to cooperate in a social dilemma would not change if efficiency was included: If someone displays a β_i value close to zero thereby caring neither for equity nor efficiency this person has consequently a low willingness to cooperate. If, in contrast, someone has high a β_i value be it for equity or efficiency concerns or both, this person is willing to cooperate provided the conditions described in Section 5.2.2 are fulfilled. In the remaining chapter we will speak of equity preferences, however, one should keep in mind the possibility that some people do not only care for equity but also for efficiency.

[31] As before, there is an exception to this rule. The value $\beta_i = 0$ is assigned to a subject who switches from pair I to pair II in #22, although the corresponding interval in this case is $-0.05 \leq \beta_i \leq 0$.

[32] In experiments designed to disentangle the importance of equity and efficiency motives the evidence is mixed. While some papers identify situations where a preference for efficiency seems to have a dominant effect (see e.g. Engelmann and Strobel 2004, Andreoni and Miller 2002) others argue that efficiency concerns are dominated by fairness concerns, i.e. by inequality aversion (see e.g. Güth et al. 2003, Levati et al. 2007).

The experiment which was conducted through the internet[33] ran over two courses, the first one lasting eight weeks from 1 June until 30 July 2007 and the second one lasting four weeks from 1 May until 31 May 2009. Participants obtained an individual login which ensured that every individual could take part only once. After subjects logged in, they read an introductory page where the decision problems in games A and B were explained. Participants were explicitly told that they could earn real money by taking part in this experiment. They were provided with a detailed explanation of how the payoffs from the experiment were determined: All participants made their decisions as Person 1 in both games (strategy elicitation method). In each of both experimental waves 10 subjects were randomly selected and matched into five pairs. For each pair one of the games (A or B) and one of the decisions (#1 to #22) were randomly selected. Finally, it was randomly decided who was to be Person 1 and Person 2 for each pair. Person 1 then received the money he or she had assigned to him- or herself in the selected decision of the selected game. Person 2 got the money Person 1 had assigned to Person 2 in that selected decision of the selected game. Since the payment mechanism involved several random draws, people were advised that the best strategy would be to make every decision as if it were to be realized. The instructions pointed out that each decision – if realized – would not only determine a subject's own payoff but also the payoff for another participant. After that, participants were presented the decision problems in games A and B (see Section 5.7.3).

The time necessary to go through all parts of the experiment was approximately 30 minutes. The expected mean payment per participant (given randomly distributed decisions and the estimate of 100 subjects per experimental wave, which had been announced in the instructions) was $8.63. The realized mean payment per selected winner (20 out of 155) was $107.00, i.e. $2140.00 were finally paid out. All random selections necessary for the payment were drawn up in the presence of a notary.[34] The money was transferred via Western Union or bank transfer and all participants were informed about their payoff via email. Participants and winners of the experiment remained anonymous, i.e. only the experimenters know their identity and their payoff.

[33] One might ask how it is possible to infer 'other-regarding preferences' by means of an internet experiment where there is no visible 'other'. In the context of climate change, however, we believe this to be justified since climate change mitigation tend to involve less visible 'abstract others'.

[34] For the sake of credibility, the contact details of the notary were announced to the subjects (see Dannenberg et al. 2010).

So far the study elicits negotiators' individual preferences. However, real-world climate negotiations are not necessarily governed by the individual preferences of the negotiators. Although the equity preferences of negotiators may play some role in the policy process, they are definitely not the sole determinant of the negotiation process. Governments form some sort of collective preference. This preference formation is a complex matter influenced by factors such as voters' preferences in their home country but also preferences of influential interest groups, for example.[35] Despite the fact that it is nearly impossible to give a full explanation for this complicated formation process, this study tries to develop a first idea of what collective (governmental) preferences in climate policy negotiations might look like. The idea is based on the assumption that the participants in the study, who had actually been involved in climate negotiations, had the best understanding of how to assess the behavior of their government, i.e. they had an informational advantage regarding the collective preference of their home country. Therefore, participants were asked to imagine that the decisions in games A and B had to be made by a group of representatives of their home country at a Conference of the Parties (COP) or a meeting of the Subsidiary Bodies (SB). Respondents then had to indicate how they believed the delegates would decide.

They were given the following opportunities for game A as well as for game B:[36]

In your opinion, how would the group of representatives of your country decide?

a) compared to my decision, the decision of the group would lead to a distribution with more money for Person 1.
b) the same way as I did.
c) compared to my decision, the decision of the group would lead to a distribution with less money for Person 1.
d) I do not know.

For both games, answer (a) "more money for Person 1", would indicate that a subject expects a more selfishly oriented group of delegates compared to his or her own preference. Accordingly, answer (c) "less money for Person 1" would indicate that a subject expects a more fair-minded government.

[35] Using a representative sample, Dohmen et al. (2008) show the importance of social preferences among the general population. Therefore, it is reasonable to assume that the median voter, who should have a decisive influence on the collective preference according to the median voter model, also has social preferences. See Congleton (2001) for a general discussion of the political economy of international environmental treaties.

[36] Answering the question regarding the expected collective preferences, subjects were not able to change their individual decisions in the games A and B completed before.

The experiment ended by asking participants to complete a final questionnaire in which they were requested to provide several personal characteristics such as gender, nationality, working field, and affiliation.

5.4 Subject pool

Approximately 2.000 people who had been involved in climate negotiations before were contacted via mail or email and asked to participate in the experiment. For this purpose, names and addresses were collected from official IPCC documents and websites. Overall, 155 people took part so that the response rate was roughly 8 %.[37] Participants came from all over the world: 37 % were from Europe, 23 % from Africa, 19 % from Asia, 8 % from South America, 7 % from Australia and Oceania, and 6 % from North America. For direct comparison, the regional distribution of participants of the recent United Nations Climate Change Conference in Copenhagen, December 2009 (COP 15) was: 32 % from Europe, 20 % from Africa, 22 % from Asia, 13 % from South America, 5 % from Australia and Oceania, and 8 % from North America. Thus, the subject pool reflected the regional distribution of COP participants fairly well. A chi square goodness-of-fit test confirms that the difference in the distribution of participants between Copenhagen and the experiment is not significant. The experimental subjects worked mostly for national governmental organizations (70 %) and universities or research institutions (15 %). A few were employed in international governmental organizations (6 %), non-governmental organizations (NGO) (3 %), and private companies (1 %). Three quarters had been to a COP or SB meeting before (see Table 5.2 for further socio-economic characteristics).

Out of 155 participants, 84 individuals (54 %) behaved consistently in game A and 103 individuals (67 %) behaved consistently in game B. In total, 69 individuals (45 %) behaved consistently in both games.[38] At a first glance these numbers appear somewhat disappointing. However, by applying the strict rules of consistency subjects who had not fully understood the rules and those who made random choices were excluded.

[37] Note that the people who had been invited to participate constitute the population and not a sample of the population. Hence it was not possible to increase the number of participants by increasing the sample.
[38] While most people who were consistent in one game behaved rationally (in the sense that their choices were not random) in the other game, people who were not consistent in both games often made completely random choices.

Since the consistency of answers was one of the study's priorities, the results described in the next section will focus on these three (sub-) groups. It is worth noting that the composition sometimes differs between all participants and the three groups. For example, while only about one quarter (28 %) of all participants come from the EU, they account for 42 % of the group who behaved consistently in game A and in game B. Conversely, approximately three quarters (72 %) of all participants are Non-EU but they only accounted for 58 % of the group who behaved consistently in game A and in game B. The reason for this may be that participants from the EU are more familiar with rather artificial decision situations such as economic experiments.

5.5 Experimental results

The participants of the study care about advantageous inequality while the majority is not concerned about disadvantageous inequality. More than 60 % of all subjects show an α_i value of zero (see Figure 5.1). The mean value of α_i is 0.394, the median is 0. For β_i, there are two peaks, each with more than 20 % of observations, at the intervals (0.5, 0.6] and (0.7, 0.8]. The mean value of β_i is 0.561, the median is 0.53.[39] This means that 50 % of participants are willing to donate half of their endowment even if donating reduces total payoffs (which is the case from #2 to #11, see Table 5.1). In previous dictator game experiments, the percentage of subjects allocating half of their endowment to the other person typically ranges between 10 % and 30 %. Mean percentage allocation to the other person is mostly around 20 % (Camerer 2003). In studies which use non-student subject pools mean percentage allocation also typically ranges between 20 % and 30 % (e.g. List 2004b, Whitt and Wilson 2007). Since the present setting was not double-blind, i.e. the experimenters knew the identity of the participants, there may be a pro-sharing bias for example due to a matter of prestige. This effect could affect the individual α_i and β_i values, however, as all participants were subject to the same procedure, the effect should not bias regional differences

[39] These values are based on the data of all subjects who were consistent in at least one game. However, the results do not significantly change if the data evaluation is limited to subjects who were consistent in both games. The student subject pool in a similar study (Dannenberg et al. 2007) showed significantly lower inequality aversion which may be explained by a higher share of economists (60 % versus 10 %) (e.g. Frey and Meier 2003) or an age effect as the climate negotiators are older (e.g. List 2004a, Sutter and Kocher 2007).

between the parameters. It turns out that there is no correlation between the two inequality parameters (Spearman's ρ for α_i and β_i is 0.166 with a *p*-value of 0.173).[40]

Since there is much geographic variety of respondents in the study, it is possible to examine the differences in equity preferences between different regions of the world. Table 5.3 summarizes the results. A series of Mann-Whitney U tests (MW U) and Kolmogorov-Smirnov tests (KS) shows that there are no significant differences in fairness parameters between EU respondents versus Non-EU respondents, G8 versus Non-G8 participants, and G77 versus Non-G77 participants. There is only a weakly significant difference at the 10 % level in α_i values between G77 and Non-G77 (see Figure 5.3). A regression analysis, with α_i and β_i as dependent variables and region, gender, age and other socioeconomic characteristics as independent variables, confirms that neither region nor other socioeconomic variables have a significant effect on fairness parameters.[41] This means that the variables collected in the experiment cannot explain the differences in individual fairness preferences.

Next, let us turn to the respondents' assumptions about collective fairness preferences. Interestingly, most participants have stated how they expect collective preferences to be related to their own preferences. Only about 18 % of subjects declared "do not know" as one possible answer to this question. Again, there are no significant differences between regions (MW U test, $p > 0.05$). This means that negotiators from the EU do not have different expectations from their government than non-EU participants. The same holds true for G8 versus Non-G8 and G77 versus Non-G77 comparisons. Figure 5.2 contains frequencies of answers separated for subjects whose inequality parameter values lie above and below the mean value.

Consider α_i first: Around 59 % of those who are less averse to disadvantageous inequality, i.e. who have an α_i below the mean value, would also expect their country delegates to not act in a very fairness-oriented way. Approximately 17 % expect them to act even more selfishly. A clear majority of those who care more about equity and show

[40] In addition, only 16 out of 69 subjects fulfill the F&S condition $\alpha_i \geq \beta_i$. This behaviorial pattern is also observed for students in Dannenberg et al. (2007). Note, however, that from a theoretical point of view, $\alpha_i \geq \beta_i$ is not essential to the theory of F&S. Particularly, it is not a necessary condition for cooperative behavior in a public good game. Instead, F&S use this condition to simplify their proofs.

[41] The regression results are available from the corresponding author upon request.

α_i values above the mean expect their country delegates to behave more selfishly: About 46 % of the respondents expect them to claim more money for Person 1 than they did for themselves. Roughly 29 % believe that their representatives would act similarly to them. The answers for the two subpopulations 'above mean' and 'below mean' are significantly differently distributed (two-sided Chi-square test p = 0.001). Furthermore, a Spearman's correlation test shows that the individual α_i values and expectations are negatively correlated (Spearman's ρ = -0.352, p = 0.003) insofar as expectations may be ranked. The ranking is 1 = "More for Person 1", 2 = "Same way", 3 = "Less for Person 1". „Do not know" responses are omitted. Summarizing, only a small minority of respondents expects country delegates to act in a more fairness-oriented way. A vast majority of both subpopulations expects the delegates of their home country to make rather selfish decisions: Most 'below mean' participants expect them to behave in the same way, i.e. to have equally low α_i values, and the majority of the 'above mean' participants expect them to have lower α_i values.

Looking at β_i the picture is slightly different and more ambiguous. Out of those who are less averse to advantageous inequality than the average, a quarter expect the same degree of inequality aversion regarding the collective preference, while nearly 38 % expect governments to be even more selfish, and approximately 20 % expect them to be less selfish. Roughly 35 % of those with values above the mean expect their delegates to behave in the same way as they did, but virtually the same percentage (37 %) expects representatives to act more selfishly. The answers for the two subpopulations are not significantly differently distributed (two-sided Chi-square test, p = 0.323). Furthermore, β_i and expectations are not correlated (Spearman's ρ = -0.031, p = 0.781). Thus, again a majority of respondents does not expect governments to act in a more fairness-oriented way: The majority of the 'above mean' participants believe that the representatives are equally fair or more selfish. The majority of the 'below mean' participants expect them to act in a similar manner or even more selfish than they did.

5.6 Conclusions

This chapter tries to shed some light on the question of how far equity considerations are important to individuals involved in climate negotiations. The notion of equity is

operationalized by introducing the concept of inequality aversion developed by Fehr and Schmidt (1999). According to their approach, people are endowed with aversion to advantageous and disadvantageous inequality to a different degree. The degree of inequality aversion is measured with the help of two simple non-strategic games which resemble the decisions in a dictator game and an ultimatum game. The main finding is that inequality is of considerable importance for the negotiators.

From a policy-oriented point of view, the most interesting and also most important question concerns the implications of the experimental findings for real-world climate negotiations. The answer is far from simple and one has to be very cautious: Real-world climate policy is a complex matter dealing with many more influences than equity attitudes only. Moreover, as already mentioned we have to be aware that equity preferences as measured in this study are probably not identical to collective preferences of countries. Despite this fact, the individual preferences elicited in this study may serve as a starting point for a discussion of the role of equity for the cooperation of countries in climate policy. As a vast majority of participants expects governments to not act in a more equity-oriented way, the individual preferences may be seen as an upper bound for inequality aversion reflected in collective preferences of countries.

The voluntary contribution game introduced in Section 5.2 lacks many features of the real-world climate problem, e.g. an explicit modeling of costs and benefits of climate policy and their asymmetric regional distribution. However, it captures the essential incentive problem the international community is confronted with, namely the voluntary provision of the global public good climate protection. Thus, despite its extreme simplicity the model may shed some light on the problems of real-world climate negotiations. What do the experimental findings imply within this modeling context?

The critical condition for achieving cooperation is given by $k/(n-1) < (m+\beta_j-1)/(\alpha_j+\beta_j)$. This condition (see Section 5.2) implies a lower bound for the critical value of k, k_{crit}, the number of countries that will defect in any case. We obtain for the lower bound $k_{crit} > 0 \Leftrightarrow m+\beta_j-1>0 \Leftrightarrow m>1-\beta_j$. Naturally, a higher degree of aversion to advantageous inequality makes it easier to meet this requirement. To state it the other way around: Low values of β_i imply that cooperation can only be

obtained if m, i.e. the MPCR of climate mitigation policies, is sufficiently high. In this study, the mean value for β_i is 0.561. Let us for convenience neglect the - rather small - regional differences and consider this mean value for β_i only. The empirical findings then imply that cooperation could be obtained only if $m > 0.439$.

Of course, currently nobody can tell whether the return of climate mitigation policies is above or below 0.4. However, what matters in real-world policies is the *perceived* return. Some countries have been very skeptical about the merits of mitigation policies in the past. The United States, for example, put a strong emphasis on the implied costs while at the same time expressing doubts about whether there are any benefits of climate policy at all. This observation leads to the conclusion that the perceived MPCR for the US in the past might have been very low, offering some explanation as to why the US has been so hesitant to adopt an active climate mitigation policy. So even if US Americans are concerned about equity issues as well, this does not automatically lead to the decision to contribute to the global public good climate protection. The simple voluntary contribution game shows that inequality aversion is not the sole determinant for the decision to cooperate, but sufficiently high returns of cooperative behavior have to be guaranteed as well. On the other hand, Europeans have mainly been optimistic about net benefits of climate policy, which may be an explanation for their self-declared leadership in climate policy. Thus, although equity may be important to Europeans and US Americans to roughly the same extent, this may not be sufficient for an agreement in climate mitigation policy. What is needed is a shared view of sufficiently high net benefits of such policies.

Moreover, condition (5.3) may partly explain why the US dropped out of the Kyoto Protocol. If we interpret m as the *perceived* MPCR of mitigation policies, one might speculate that for the Clinton-Gore administration, the return of active climate policy was sufficiently high to assure that $m + \beta_j - 1 > 0$, thus allowing for the possibility to take part in a climate treaty. Even if $m + \beta_j - 1 > 0$, the problem of what an acceptable number of countries not abiding by their own substantial obligations would remain. This issue has been discussed extensively in the US. The US Senate, for example, unanimously argued that important developing countries should not be allowed to stay

outside the Kyoto Protocol.[42] In any case, for the Bush administration, the perceived MPCR of climate policy has presumably been much lower, so that $m+\beta_j-1<0$, making participation in a climate treaty no longer worthwhile. This interpretation is in line with the quantitative results derived by Nordhaus and Yang (1996) who show that the net benefits of mitigation are lower for the US than for Europe. Evidently, the Obama administration has a different view on the benefit-to-cost ratio of mitigation policy, although it is too early to assume a fundamental change in US climate policy.

In the following, we turn to a discussion of some more specific results of the study. Considering alternative groupings of countries such as G8 versus Non-G8 or EU versus Non-EU countries there are no significant differences, neither for individual preferences nor for expected collective preferences. Therefore, regional differences in addressing climate change are more likely to be driven by national interests than by different equity concerns. Given the huge differences in socio-economic circumstances between different regions of the world, the absence of significant differences in preferences seems to be a remarkable result. On average, inequality aversion appears to be rather similar across regions – at least if one compares individuals from a specific group, namely people involved in international climate negotiations. This finding is in line with the experimental literature on cross-country or cross-cultural comparisons. While there are often significant differences in individual behavior between countries or cultures (e.g. Henrich et al. 2001, Ferraro and Cummings 2007) these differences tend to disappear if experimenters use subjects with a common background such as students or business people (e.g. Bouckaert and Dhaene 2004). Therefore, it is possible that an investigation based on a broader data set would discover more asymmetrically distributed equity preferences. It might also be that those preferences – rather than negotiators' views – are the driving force behind a country's climate policy. However, given the relevance of negotiators' personal preferences for the outcome of climate negotiations and the findings of other studies also analyzing negotiators' opinions about equity (Lange et al. 2010) our line of reasoning seems most plausible.

[42] This has been codified in the Byrd-Hagel resolution passed with unanimity before COP3 in 1997. The Byrd-Hagel resolution makes substantial reduction measures on the part of important developing countries a prerequisite for the US to participate in the Kyoto Protocol. Although many believe that this resolution was motivated purely strategically, our discussion shows that there might be some underlying economic rationale, since it could be the result of a positive return of climate policy which is, however, perceived as too low.

5.7 Appendix

5.7.1 Tables

Table 5.1: Payoffs in preference elicitation games

		game A					game B				
		pair I		pair II			pair I		pair II		
		payoffs (in $) for person					payoffs (in $) for person				
	#	1	2	1	2	α_i	1	2	1	2	β_i
switching point from pair I to pair II	1	100.00	100.00	40.00	40.00	-	200.00	0.00	0.00	0.00	1.00
	2	88.80	111.20	40.00	40.00	2.18	200.00	0.00	10.00	10.00	0.98
	3	88.40	111.60	40.00	40.00	2.13	200.00	0.00	20.00	20.00	0.93
	4	87.80	112.20	40.00	40.00	2.02	200.00	0.00	30.00	30.00	0.88
	5	87.20	112.80	40.00	40.00	1.90	200.00	0.00	40.00	40.00	0.83
	6	86.40	113.60	40.00	40.00	1.77	200.00	0.00	50.00	50.00	0.78
	7	85.80	114.20	40.00	40.00	1.66	200.00	0.00	60.00	60.00	0.73
	8	84.80	115.20	40.00	40.00	1.54	200.00	0.00	70.00	70.00	0.68
	9	83.80	116.20	40.00	40.00	1.41	200.00	0.00	80.00	80.00	0.63
	10	82.80	117.20	40.00	40.00	1.30	200.00	0.00	90.00	90.00	0.58
	11	81.40	118.60	40.00	40.00	1.18	200.00	0.00	100.00	100.00	0.53
	12	78.40	121.60	40.00	40.00	1.00	200.00	0.00	110.00	110.00	0.48
	13	77.20	122.80	40.00	40.00	0.85	200.00	0.00	120.00	120.00	0.43
	14	76.20	123.80	40.00	40.00	0.79	200.00	0.00	130.00	130.00	0.38
	15	73.60	126.40	40.00	40.00	0.70	200.00	0.00	140.00	140.00	0.33
	16	70.60	129.40	40.00	40.00	0.58	200.00	0.00	150.00	150.00	0.28
	17	66.60	133.40	40.00	40.00	0.46	200.00	0.00	160.00	160.00	0.23
	18	57.00	143.00	40.00	40.00	0.30	200.00	0.00	170.00	170.00	0.18
	19	54.40	145.60	40.00	40.00	0.18	200.00	0.00	180.00	180.00	0.13
	20	44.40	155.60	40.00	40.00	0.10	200.00	0.00	190.00	190.00	0.08
	21	28.60	171.40	40.00	40.00	0.00	200.00	0.00	200.00	200.00	0.03
	22	2.00	198.00	40.00	40.00	-0.14	200.00	0.00	210.00	210.00	0.00

Note: The computation of the F&S parameters is illustrated for parameter α_i and a subject who switches from pair I to II in #11: According to (5.2) for this subject the following conditions hold: $82.80 - \alpha_i \left(82.80 - 117.20\right) > 40.00$ and $40.00 > 81.40 - \alpha_i \left(81.40 - 118.60\right)$. Given these decisions we can compute the lower bound ($\alpha_i > 1.113$) and the upper bound ($\alpha_i < 1.244$) for the parameter. The mean value is $\alpha_i = (1.113 + 1.244)/2 = 1.18$.

Table 5.2: Socio-economic characteristics of participants

Participants	All		Consistent in A		Consistent in B		Consistent in A and B	
Frequency	Abs.	in %	Abs.	in %	Abs.	in %	Abs.	in %
Gender								
Female	31	20.0	16	19.0	22	21.4	13	18.8
Male	119	76.8	64	76.2	78	75.7	54	78.3
No answer	5	3.2	4	4.8	3	2.9	2	2.9
Age								
20 – 29	16	10.3	3	3.6	4	3.9	2	2.9
30 – 39	49	31.6	27	32.1	32	31.1	22	31.9
40 – 49	40	25.8	22	26.2	28	27.2	17	24.6
50 – 59	41	26.5	26	31.0	33	32.0	23	33.3
60 – 69	3	1.9	1	1.2	2	1.9	1	1.4
No answer	6	3.9	5	6.0	4	3.9	4	5.8
Continent								
AFR	36	23.2	12	14.3	12	11.7	7	10.1
AOZ	10	6.5	5	6.0	5	4.9	4	5.8
ASI	30	19.4	16	19.1	19	18.4	12	17.4
EUR	57	36.8	40	47.6	51	49.5	35	50.7
NAM	9	5.8	4	4.8	7	6.8	4	5.8
SAM	13	8.4	7	8.3	9	8.7	7	10.1
EU/Non-EU								
EU	43	27.7	33	39.3	40	38.8	29	42.0
Non-EU	112	72.3	51	60.7	63	61.2	40	58.0
G8/Non-G8								
G8	28	18.1	20	23.8	26	25.2	18	26.1
Non-G8	127	81.9	64	76.2	77	74.8	51	73.9
G77/Non-G77								
G77	83	53.5	37	44.1	40	38.8	28	40.6
Non-G77	72	46.5	47	56.0	63	61.2	41	59.4
Field								
Natural sciences	64	41.3	33	39.3	45	43.7	27	39.1
Political sciences	8	5.2	5	6.0	8	7.8	5	7.2
Economics/Business administration	16	10.3	11	13.1	12	11.7	10	14.5
Law	6	3.9	3	3.6	4	3.9	2	2.9
Engineering	28	18.1	15	17.9	14	13.6	11	15.9
Other	33	21.3	17	20.2	20	19.4	14	20.3
Organisation								
International governmental institution	9	5.8	5	6.0	6	5.8	4	5.8
National governmental institution	108	69.7	59	70.2	70	68.0	48	69.6
University or research institution	23	14.8	11	13.1	18	17.5	10	14.5
Private company	2	1.3	1	1.2	1	1.0	1	1.4
NGO	5	3.2	3	3.6	2	1.9	2	2.9
Other	8	5.2	5	6.0	6	5.8	4	5.8
COP/SBI or SBSTA participation								
Yes	116	74.8	62	73.8	76	73.8	50	72.5
No	32	20.6	18	21.4	23	22.3	16	23.2
No answer	7	4.5	4	4.8	4	3.9	3	4.3
Σ	155	100.0	84	100.0	103	100.0	69	100.0

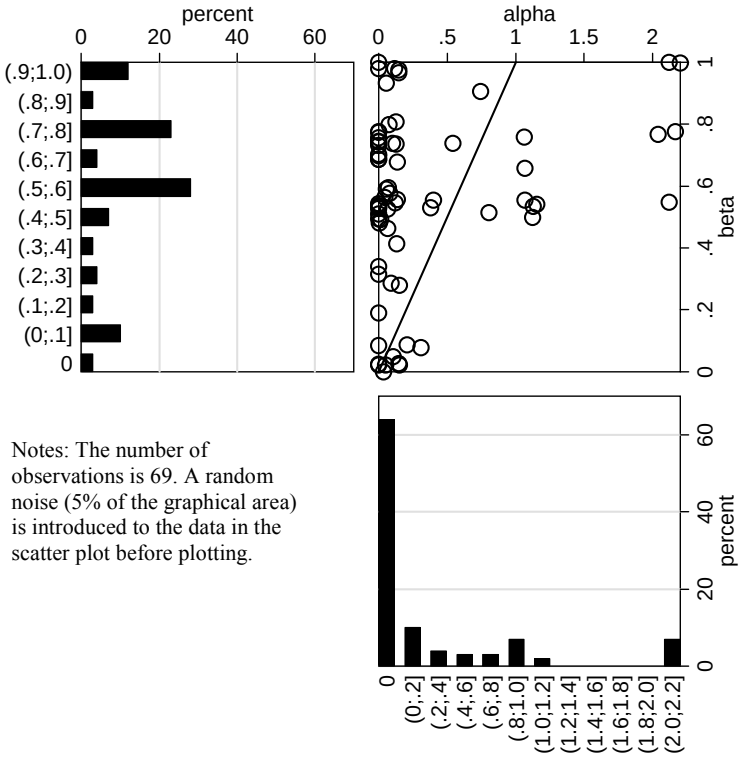
Table 5.3: Regional differences for fairness parameters

	alpha			beta		
regional split	mean	MWU test*	KS test*	mean	MWU test*	KS test*
EU	0.388	0.379	0.784	0.525	0.234	0.242
Non-EU	0.398			0.584		
G8	0.275	0.118	0.399	0.503	0.186	0.366
Non-G8	0.432			0.581		
G77	0.472	0.075	0.219	0.603	0.102	0.160
Non-G77	0.333			0.535		

Notes: * columns contain *p*-value for the test of significance. Results remain virtually unchanged if the analysis is limited to subjects who are consistent in both games.

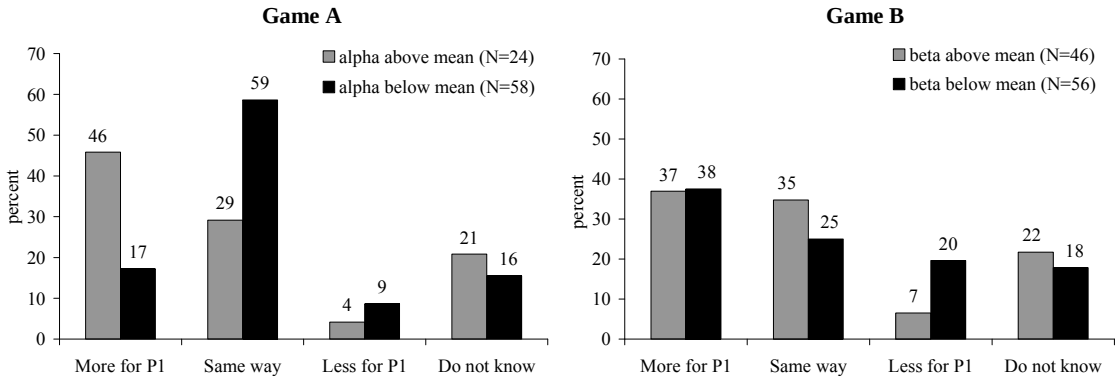
5.7.2 Figures

Figure 5.1: Joint distribution of fairness parameters

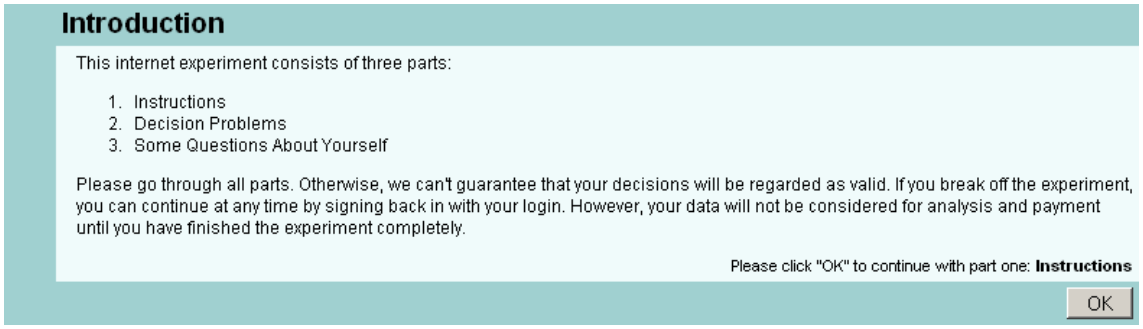


Notes: The number of observations is 69. A random noise (5% of the graphical area) is introduced to the data in the scatter plot before plotting.

Figure 5.2: Collective vs. individual fairness preferences



5.7.3 Experimental instructions



1. Instructions

In this experiment you have the chance to **earn real money**, up to $210. You need, however, some time and concentration to go through the instructions. Please read all the instructions carefully. Your decisions in the experiment will be anonymous. Only the experimenter, i.e. the ZEW research team, will get to know your identity, but all data will be treated confidentially.

In the experiment you will have to make decisions in two Decision Problems, A and B. The rules of the Decision Problems as well as the payment of money will be explained in the following. If you have any questions, please contact Dr. Bodo Sturm via e-mail (sturm@zew.de).

1.1 Rules for the Decision Problems A and B

There are two persons, Person 1 and Person 2, in the Decision Problems A and B. Certain amounts of money will be split between the two persons. There are two options, Option I and Option II, to split the money.

Person 1 always has to select one of the two options. Person 2 has no choice but has to accept the decision made by Person 1.

In the experiment **you will always decide in the role of Person 1**, i.e. you will decide how to split the money between yourself (Person 1) and Person 2. You have to choose between the two options 22 times in Decision Problem A and 22 times in Decision Problem B.

1.2 Examples

Below, you can see an example for the Decision Problem A (Decision Problem B looks similar). In the example, only the decision of Person 1 in No. 5 is depicted. Later in the experiment there will be No. 1 to No. 22. Person 1 has chosen Option I in No. 5 (as indicated with "X"). The decision depicted in the example would assign $90.00 to himself or herself and $110.00 to Person 2. Option II would have assigned $40.00 to both persons.

Decision Problem A
Person 1 chooses between Option I and Option II.
- Payoff in US$ -

No.	Option I			Option II		
	Choice	Person 1	Person 2	Choice	Person 1	Person 2
...		...	...		...	...
5	X	90.00	110.00		40.00	40.00
...		...	...		...	...

Please click "OK" to continue with the second part of the instructions: **Determination of Payoffs**

OK Back

1. Instructions

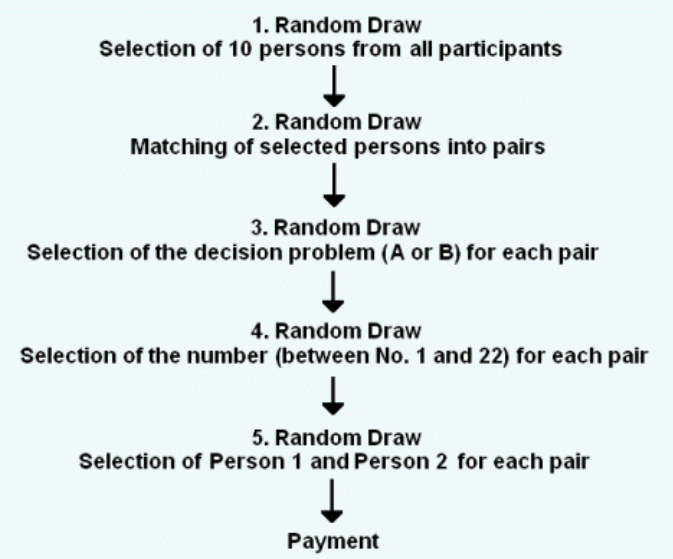
1.3 Determination of Payment

As mentioned above, you have the chance to earn real money in this experiment. Whether you will get money and how much depends on two factors: (1.) your decisions in the Decision Problems A and B **or** the decisions of other participants in the Decision Problems A and B and (2.) chance.

We expect about 100 participants in total in the experiment. Each of them runs through the same decision problems, i.e. **all of the participants decide as Person 1** in Decision Problems A and B. After completion we randomly select 10 participants and match them into pairs. For each pair we randomly select one of the Decision Problems (A or B) and one of the numbers (No. 1 to 22). Finally, we randomly select for each pair who is Person 1 and who is Person 2. Person 1 will get the money he or she has assigned to himself or herself in the selected No. of the selected decision problem. Person 2 will get the money Person 1 has assigned to Person 2 in that No. of the selected decision problem. For the sequence of random draws, see figure below. All random selections will be drawn up before a notary (Mr. Werner Eichorn, Mannheim/Germany, see: www.notar-eichhorn.de).

This payment rule has the following consequences: **Your decisions** may not only determine your own earnings but also the earnings of another participant. As a random draw decides who finally is selected Person 1, there is **no interaction** between participants. If you randomly end up as Person 2 there is no possibility to influence the decisions of Person 1. Each of the 44 decisions you will have to make in the Decision Problems A and B has the same probability to be realized. Thus, the **best strategy** is making every decision in a way as if it were to be realized.

The money will be disbursed via Western Union (see www.westernunion.com) without any organizational effort for you. In any case, all participants will be informed about the individual payment from the experiment via e-mail, i.e. you will be informed only about your own payment. Therefore, please do not forget to indicate your e-mail address at the end of the experiment.



Please click "OK" to continue with a **Summary** of the instructions.

OK Back

1. Instructions

1.4 Summary

Before the experiment will start, please remember the most important features:

1. You have the chance to earn real money.
2. Your decisions may determine not only your own earnings but also the earnings of another participant.
3. There is no interaction between participants.
4. All participants decide as Person 1. Whoever will be selected Person 1 or Person 2 in the end is random.
5. The best strategy is making every decision in a way as if it were to be realized.

If you have any questions, please contact Dr. Bodo Sturm (sturm@zew.de).

Please click "OK" to continue with part two: **Decision Problems**

OK Back

2. Decision Problems

2.1 Decision Problem A

Person 1 chooses between Option I and Option II
- payoff in $ -

No.	Option I			Option II		
	Choice	Person 1	Person 2	Choice	Person 1	Person 2
1	◉	100.00	100.00	○	40.00	40.00
2	◉	88.80	111.20	○	40.00	40.00
3	◉	88.40	111.60	○	40.00	40.00
4	◉	87.80	112.20	○	40.00	40.00
5	◉	87.20	112.80	○	40.00	40.00
6	◉	86.40	113.60	○	40.00	40.00
7	◉	85.80	114.20	○	40.00	40.00
8	◉	84.80	115.20	○	40.00	40.00
9	◉	83.80	116.20	○	40.00	40.00
10	◉	82.80	117.20	○	40.00	40.00
11	◉	81.40	118.60	○	40.00	40.00
12	◉	78.40	121.60	○	40.00	40.00
13	◉	77.20	122.80	○	40.00	40.00
14	◉	76.20	123.80	○	40.00	40.00
15	◉	73.60	126.40	○	40.00	40.00
16	◉	70.60	129.40	○	40.00	40.00
17	○	66.60	133.40	◉	40.00	40.00
18	○	57.00	143.00	◉	40.00	40.00
19	○	54.40	145.60	◉	40.00	40.00
20	○	44.40	155.60	◉	40.00	40.00
21	○	28.60	171.40	◉	40.00	40.00
22	○	2.00	198.00	◉	40.00	40.00

Hint: Please decide as Person 1 by clicking either on Option I or Option II, i.e. you have to decide 22 times, which option you prefer. All payoffs are in US Dollars.

Please click "OK" to continue with **Decision Problem B**.

OK Back

2. Decision Problems

2.1 Decision Problem B

Person 1 chooses between Option I and Option II

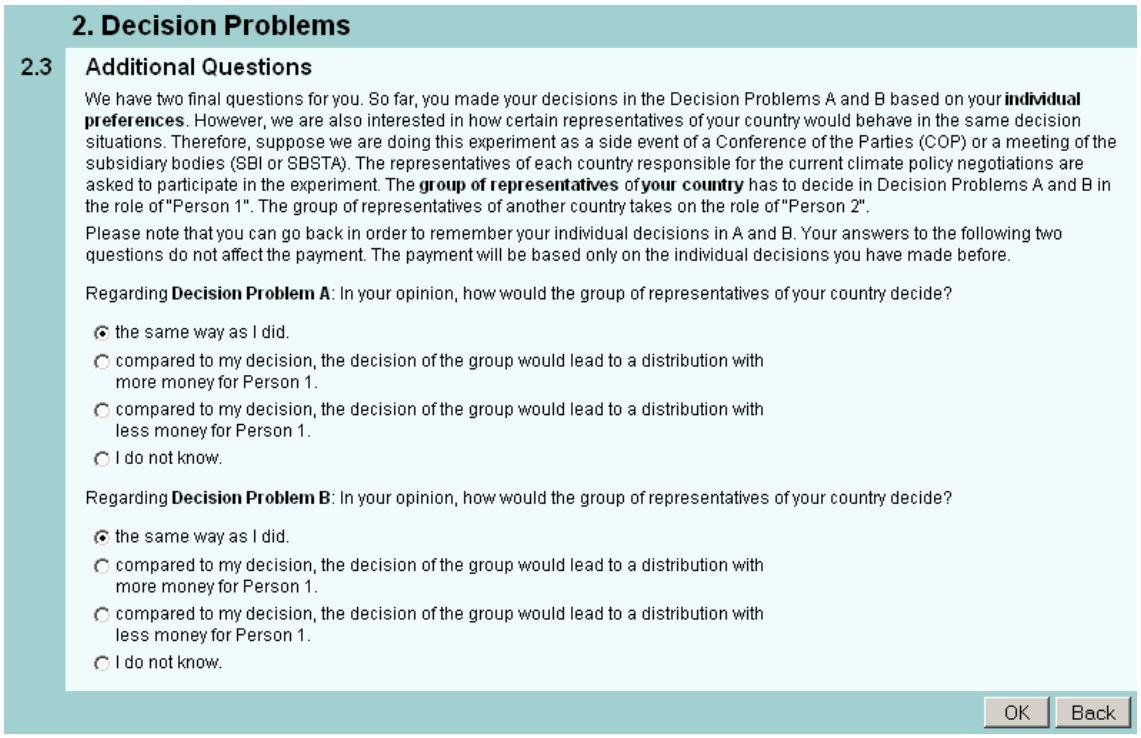
- payoff in $ -

No.	Option I			Option II		
	Choice	Person 1	Person 2	Choice	Person 1	Person 2
1	◉	200.00	0.00	○	0.00	0.00
2	◉	200.00	0.00	○	10.00	10.00
3	◉	200.00	0.00	○	20.00	20.00
4	◉	200.00	0.00	○	30.00	30.00
5	◉	200.00	0.00	○	40.00	40.00
6	◉	200.00	0.00	○	50.00	50.00
7	◉	200.00	0.00	○	60.00	60.00
8	◉	200.00	0.00	○	70.00	70.00
9	◉	200.00	0.00	○	80.00	80.00
10	◉	200.00	0.00	○	90.00	90.00
11	◉	200.00	0.00	○	100.00	100.00
12	◉	200.00	0.00	○	110.00	110.00
13	◉	200.00	0.00	○	120.00	120.00
14	○	200.00	0.00	◉	130.00	130.00
15	○	200.00	0.00	◉	140.00	140.00
16	○	200.00	0.00	◉	150.00	150.00
17	○	200.00	0.00	◉	160.00	160.00
18	○	200.00	0.00	◉	170.00	170.00
19	○	200.00	0.00	◉	180.00	180.00
20	○	200.00	0.00	◉	190.00	190.00
21	○	200.00	0.00	◉	200.00	200.00
22	○	200.00	0.00	◉	210.00	210.00

Hint: Please decide as Person 1 by clicking either on Option I or Option II, i.e. you have to decide 22 times, which option you prefer. All payoffs are in US Dollars.

Please click "OK" to continue with some **Additional Questions**.

OK Back



2. Decision Problems

2.3 Additional Questions

We have two final questions for you. So far, you made your decisions in the Decision Problems A and B based on your **individual preferences**. However, we are also interested in how certain representatives of your country would behave in the same decision situations. Therefore, suppose we are doing this experiment as a side event of a Conference of the Parties (COP) or a meeting of the subsidiary bodies (SBI or SBSTA). The representatives of each country responsible for the current climate policy negotiations are asked to participate in the experiment. The **group of representatives** of **your country** has to decide in Decision Problems A and B in the role of "Person 1". The group of representatives of another country takes on the role of "Person 2".

Please note that you can go back in order to remember your individual decisions in A and B. Your answers to the following two questions do not affect the payment. The payment will be based only on the individual decisions you have made before.

Regarding **Decision Problem A**: In your opinion, how would the group of representatives of your country decide?

- (•) the same way as I did.
- ( ) compared to my decision, the decision of the group would lead to a distribution with more money for Person 1.
- ( ) compared to my decision, the decision of the group would lead to a distribution with less money for Person 1.
- ( ) I do not know.

Regarding **Decision Problem B**: In your opinion, how would the group of representatives of your country decide?

- (•) the same way as I did.
- ( ) compared to my decision, the decision of the group would lead to a distribution with more money for Person 1.
- ( ) compared to my decision, the decision of the group would lead to a distribution with less money for Person 1.
- ( ) I do not know.

OK Back

6 The effects of third-party input on voluntary public goods contributions

6.1 Introduction

This chapter investigates if third-party input to the provision of a public good affects the willingness to contribute to that public good. Unlike all previous chapters, the public good examined in this (and the following) chapter does not refer to climate change mitigation but to charitable donations. There are several reasons to take charitable donations (see Chapter 1) including the following two: First, charitable donations, e.g. to development aid, are well suited to measure the willingness to contribute to a specific public good. In contrast, it is very difficult to elicit the individual willingness to pay for climate protection because these contributions often take the form of behavior modifications, i.e. opportunity costs, instead of direct payment. Second, third-party input to the public good is given by the charity's revenues. When individuals make a real-life donation decision, they usually do not have precise information about a charity's income streams. They do not know whether and how much their neighbors or other people in their social community donate to a certain charity. Furthermore, it is questionable whether they are aware of the exact amount of government subsidies given to that charity. However, they probably have a belief about the charity's size in terms of entire revenues, i.e. whether it is small or large.

Therefore, this study examines the effects of information about the revenues of a charity on the willingness to donate to that charity. Various approaches may be relevant here: Theoretical models predict complete or incomplete crowding out of voluntary contributions by government financial support. Furthermore, an impact philanthropist may prefer to give to smaller charities to increase the relative impact of his or her donation, while the approaches of quality signaling and conditional cooperation predict that larger charities may be chosen more frequently. So far, however, experimental studies have examined either the effect of government financial support on voluntary contributions or the effect of social information on private donations but not the *net* effect. Experimental evidence hints at incomplete crowding out of private donations by government subsidies, while several studies on social information find a positive relation between others' contributions and those of one's own.

To fill this gap in the literature, a framed field experiment was conducted where a non-student subject pool was asked to make a real donation decision. Half of the subjects could choose whether to give to a charity with relatively low annual revenues or to a charity with relatively high annual revenues. To the best of our knowledge, this study is the first that presents evidence on the net effect and it shows a negative relation between a charity's entire revenues and private donations to that charity.

The outline of this chapter is as follows: Section 6.2 summarizes the findings of the relevant theoretical and empirical literature and motivates the experimental framework. Section 6.3 describes the experimental setting and Section 6.4 part delivers the results. Section 6.5 concludes.

6.2 Theoretical and empirical background

Third-party contributions to a charity may stem from governmental subsidies or other individuals' donations, respectively. Theoretical models and empirical studies have looked at the effects of both sources of charities' income on private donations.

The standard public goods model (Warr 1982, Roberts 1984, Bergstrom et al. 1986) predicts that private voluntary contributions are completely crowded out by government contributions to the same good. In this model, an individual derives utility from his private consumption as well as the total supply of the public good. If a contributing individual is taxed in order to finance the public good, he decreases his voluntary contributions by exactly the same amount, as long as the taxes to be paid do not exceed the voluntary contribution he made previously to the taxation. It is reasonable, though, to assume that a potential donor also derives positive utility from the mere act of contributing. Andreoni (1989, 1990) coined the term 'warm glow' to describe such preferences, where an individual's utility increases with the amount contributed. In this case, government contributions are not a perfect substitute for voluntary contributions, which implies that the former crowd out the latter only incompletely: An individual's contribution decreases by less than the exact amount of government contributions.[43]

[43] Steinberg (1987) proposes a model of mixed motives in which donations may not necessarily be a normal good. He shows that individuals' contributions may rise or fall in response to an increase in government's contributions. Moreover, Ribar and Wilhelm (2002) show that with impurely altruistic preferences both asymptotically zero and asymptotically complete crowding out may occur.

The empirical evidence on the theoretical predictions of crowding out is mixed. In a literature review, Steinberg (1991) concludes crowding out of private charitable contributions by government spending to be between 0.5% and 35%. Also, more recent studies provide evidence for incomplete crowding out (among others Ribar and Wilhelm 2002, Gruber and Hungerman 2007, Andreoni and Payne 2010). There is, however, also empirical evidence for crowding in of voluntary contributions (Khanna et al. 1995, Khanna and Sandler 2000, Payne 2001). Arulampalam et al. (2009) use charity-level data for the special case of UK overseas development charities. They find no crowding out of donations to development by official development assistance. Their results rather hint at a modest positive effect of government grants on private giving. This implies that donors may be attracted to charities which receive substantial support from the state.

Furthermore, several laboratory experiments try to test the hypothesis of complete crowding out. Andreoni (1993) compares two groups of subjects that use the same mechanism to provide a public good, but face different levels of government provision. A minimum contribution level of two tokens is meant to resemble a tax which is used to finance a public good. If there was complete crowding out, average contributions (including the two tokens tax) should be the same in both groups. However, the author finds that crowding out is incomplete. Chan et al. (2002) use the same mechanism to confirm the result and extend it by the finding that crowding out increases as the size of the involuntary transfer increases. Bolton and Katok (1998) let subjects play a dictator game and vary the initial endowments of dictators and recipients (from \$15 for the dictator and \$5 for the recipient to \$18 and \$2, respectively). They find that the proportion of non-givers does not differ across the treatments, but that individuals in the 15-5 treatment give less, so there is some crowding out. Eckel et al. (2005) use the same mechanism, but control for fiscal illusion and the recipients are charities. If there is no fiscal illusion, i.e. the subject knows that the initial allocations are resulting from being taxed, there is support for the theoretical prediction of complete crowding out. In case of fiscal illusion, however, crowding out is zero. Konow (2010) keeps the endowment of the dictator fixed but changes the endowment of the recipient in the subsidy treatment from \$0 to \$4 and confirms the result of partial crowding out.

As charities do not only earn income from government contributions, further theoretical approaches have to be taken into account. Duncan's (2004) theory of impact

philanthropy relates to individuals who aim at having a distinct effect on the supply of a charitable good, i.e. they want to 'personally make a difference'. Hence, an impact philanthropist may benefit from a charity's lower income. This is because an increase in the revenues of a charity or others' contributions causes negative externalities: The importance and the impact of the philanthropist's donation are reduced. It then may be that an impact philanthropist – if provided with the choice between two charities of different size – chooses to give to the charity with smaller income streams because this increases the relative impact of his gift.[44] Moreover, an impact philanthropist dislikes financing the administrative costs of a charity. If a philanthropist assumes larger charities to have greater administrative costs, he would prefer to give to the smaller organization. In yet another theoretical model, Andreoni (1998) assumes the existence of a non-convexity in the production function of the public good, i.e. a minimum threshold that must be met for the public good to be consumed. He shows that in this case others' contributions may be regarded as substitutes for one's own.

On the other hand, however, models have been proposed which suggest that a positive effect of third-party contributions on individuals' donations may prevail. One approach is to model contributions by other individuals as a signal of the charity's quality as Vesterlund (2003) suggests. Typically, donations are not made simultaneously, but rather in a sequential manner, where high donations by other individuals suggest a high-quality charity which may induce individuals to give larger amounts to that organization. Andreoni (2006) remarks that leadership gifts may also be perceived as a signal for the respective charity's quality. To make this signal credible, however, the leadership gift has to be sufficiently high. So, if a charity with higher revenues is perceived to be of a higher quality it should be targeted by donors more likely than a charity with lower revenues. What is more, the phenomenon of conditional cooperation predicts that individuals will be more willing to contribute if they know that others contribute (Fischbacher et al. 2001).

Several natural field experiments investigate how information about others' contributions affects charitable donations. Frey and Meier (2004) present evidence from a large-scale field experiment on conditional cooperation. They find that when students

[44] The theoretical model suggested by Duncan, however, leads to no clear predictions how a change in the endowment of a charity or in the contributions of others would affect the size of the gift.

are presented with information that many other fellows donated to certain charitable funds, their willingness to contribute increases. The studies of Croson and Shang (2008, 2009) support this finding. Their setting is an on-air fundraising campaign for a public radio station where another member's contribution is mentioned to participants before they make their own pledge. The results of their field experiment show that (social) information about others' high contributions influences one's own contributions positively. The information effect also works downwardly. When renewing donors are presented with information about another donor's contribution which is either above or below their last year's contribution, respondents adjust their contribution in the direction of the information (Croson and Shang 2008). Croson and Shang (2010), however, demonstrate a natural limitation of the social information effect. When the social information is too extreme, it may lead to lower individual contributions. Also, Martin and Randal (2008) show that donors positively respond to information about others' contributions. Using field data from an art gallery, they find that depending on the composition of coins and bills in a transparent donation box, the more bills are exhibited relative to coins the lower is the participation rate and the higher is the average donation. While these two opposing effects level off, so that similar total donation amounts are realized across these treatments, a displayed donation box which is empty induces lower overall donations.[45]

In summary, previous experimental studies indicate that there is incomplete crowding out of voluntary contributions by government contributions and that providing information about others' contributions increases either the propensity to donate, the size of the donation, or both. The experimental approach used here differs from previous experiments in two important aspects. First, the information presented to each subject in our experiment consists of two intervals stating the yearly revenues received by an organization which comprises donations, membership fees and public subsidies. This kind of information is deemed to be very close to the situation potential donors find themselves in the real world, as they usually cannot distinguish the size of other donors' gifts and may not be aware of the extent to which a charity receives government

[45] The experimental literature on seed money may also be used to study the effect of information on charitable giving. In seed money experiments, it is announced that some particular amount has already been collected or provided by an anonymous donor or institution. List and Lucking-Reiley (2002), Landry et al. (2006), and Rondeau and List (2008) all find a positive effect of seed money on individual donations.

subsidies. The information is provided to distinguish charities by their size. Donations to larger organizations could mirror the fact that charities' revenues serve as a signal for good quality of a charity whereas donations to smaller organizations might reflect crowding out at the organization level or the aim at having a higher relative impact through the donation. This framework, however, is not meant to test for crowding out of voluntary contributions to a certain public good, e.g. development aid. If a subject chooses to give to a small development organization instead of the large one, he or she still consumes the public good. Hence, crowding out rather happens on the organizational level.

Second, a framed field experiment is used rather than a natural field experiment or a conventional lab experiment. Unlike in a natural field experiment, subjects in a framed field experiment undertake the task in an artificial environment and know that they are part of an experiment (Harrison and List 2004). Although this may bias the subjects' behavior to some extent, a framed field experiments offers advantages in terms of more control and the elicitation of personal characteristics of the participants. In addition, the donation decisions are made completely anonymously in the experimental setting. In door-to-door-fundraising, solicitation letter campaigns or other kinds of donation campaigns the identity of the donor is usually known to the organization. By means of the double-blind procedure, however, neither other experimental subjects nor the experimenter know the amount of the donation made by a certain donor. This procedure rules out an experimenter effect or certain motivations such as signaling of wealth, prestige or social approval. That such social incentive effects can arise from removing anonymity is shown in the field (Soetevent 2005) as well as in the lab (Hoffman et al. 1994, Andreoni and Petrie 2004).

Furthermore, framed field experiments are characterized by a non-student subject pool and a field context in the commodity, and therefore offer more realism than conventional lab experiments (Harrison and List 2004). A weakness of lab experiments is often seen in the weak representativeness of the sample and thus the lacking generalizability of results. Especially in the case of donation decisions representativeness might be important. Carpenter et al. (2008) for example show in a laboratory experiment that students tend to be less likely to donate to a charity than members from the broader community.

6.3 Experimental design

6.3.1 Implementation and participants

For subject recruitment, invitation letters were randomly distributed in the city of Mannheim, Germany. The letter contained an invitation to take part in a scientific study and informed people that they would receive €40 for participation. It was announced that there would be a kind of survey in which they could (voluntarily and anonymously) make consumption decisions. A relatively high show-up fee was used in order to avoid underrepresentation of people with high opportunity costs of time. Furthermore, the invitation letter already emphasized that the money was a reward for participation in the study in order to make people feel entitled to their endowment and to avoid a bias due to unexpected gift money. The experiment took place in July 2009 on the premises of the Centre for European Economic Research (ZEW) in Mannheim. A total of 223 participants took part in the experiment. At the beginning of each session, participants individually drew lots to determine their ID number (which remained unknown to other participants and the experimenters) and chose a table. The tables had privacy screens on every side to ensure private decisions and answers. Participants were not allowed to talk to each other. If they had questions, the experimenters answered them privately. The 12 experimental sessions lasted around 60 minutes each. Within one session, all subjects performed exactly the same task. At first, all participants obtained detailed instructions about the course of the experiment (see Section 6.6.3 for experimental instructions). The main features were orally repeated. It was emphasized that all information given in the instructions was true. Participants in all treatments filled out a questionnaire with questions about socio-demographic characteristics, their donation habits, and their attitude toward their own social standing within society and toward governmental responsibilities. The attitudinal questions were taken from the German General Social Survey (ALLBUS) which is conducted every two years with a representative sample of the German population.[46] At the end of each session, participants had the chance to comment on the experiment and to give reasons for their decisions (see Figure 6.3 for an overview of the experimental proceedings).

[46] For detailed information, see http://www.gesis.org/en/services/data/survey-data/allbus/ (accessed in October 2010).

Participants' socio-demographic characteristics are shown in Tables 6.6 and 6.7. The subject pool is highly diversified with, for example, age ranging from 18 to 75 years. Although it is not fully representative of the German resident population, it is sufficiently diversified in all socio-demographic variables in order to examine the influence of each variable on charitable behavior. Moreover, in case of gender, income, and religion, the distribution of the subject pool does not significantly differ from that of the German population (chi squared test, t-test, $p>0.1$).[47] More precisely, 46.2% of subjects are male. 22.9% dispose of a monthly net household income of less than €1,000, most of the subjects live in households with incomes between €1,000 and €3,000 and only 13.0% have more than €3,000 per month disposable. With regard to religion, Catholics (31.4%) and Protestants (31.8%) are equally represented, whereas 6.7% possess another religious affiliation and 30.0% of all subjects do not belong to any religious community. Participants' responses to questions regarding their giving behavior in the past as well as their attitudes are displayed in Tables 6.8 and 6.9.

6.3.2 Experimental treatments

The experiment comprised two treatments which both contained a real donation stage where subjects simultaneously and independently decided how much (if any) of their endowment to donate to a certain charity. Subjects were informed that all of the selected charities have obtained the 'DZI Spendensiegel', a label for charities that use their funds economically and according to their statutes.[48] Subjects could choose one of four charitable causes, namely disabled care, development aid, medical research, and animal protection, whereby subjects knew only the purpose but not the name of the organizations to avoid any reputation effects. All donation decisions were completely voluntary and anonymous. We used a double-blind procedure in which neither other subjects nor experimenters came to know if, how much and to which cause a subject donated. Subjects received a large envelope containing two small envelopes and the endowment of €40 broken into two 10-euro notes, one 5-euro note, six 2-euro coins, and three 1-euro coins. This breakdown enabled subjects to donate any integer amount between €0 and €40 and abated incentives to only give the coins. Subjects placed the

[47] Unless stated otherwise, all tests in this chapter are two-sided.
[48] For more information (in German language), see www.dzi.de (accessed in October 2010).

amount they wished to donate in one of the small envelopes assigned to donations, labeled the envelope with their ID number and, in case they were willing to give a positive amount, the charitable cause to which they wished to donate. The amount of money subjects wished to keep for themselves was placed in the other small envelope. Afterwards, subjects dropped the sealed envelope specified for donations in a box.

The baseline treatment (*'NoInfo'*) with 113 subjects involved the above described donation stage and afterwards the completion of the questionnaire. The 110 subjects in the treatment *'Info'* were informed not only about the charitable cause of the organizations but also about their revenues taken by donations, membership fees and public subsidies in 2006. For each charitable cause, two organizations were offered: one relatively small organization with revenues between €40,000 and €300,000 and one relatively large organization with revenues between €5 million and €11 million. Thus, subjects in this treatment could choose one of eight organizations for their donation. All donations made during the experiment were transferred in full to the respective organizations. In case of the *NoInfo* treatment, donations were equally assigned to small and large organizations of the same cause. The counting of donations and the transfer to the organizations were notarially monitored and certified. This procedure and the name of the notary were already announced in the experimental instructions.[49]

6.4 Experimental results

6.4.1 Treatment effects

In total, €1,225 are donated to the charities. Mean donation per participant is €5.49 or 13.7% of the endowment, median donation is €3.00. Broken down by purposes, €448 are donated to disabled care, €318 to development aid, €274 to medical research, and €185 to animal protection. Disabled care is not only the purpose which is selected most frequently (21%) but which also receives the highest average donations (9.53€). While individual donations do not differ significantly between the four purposes, subjects select animal protection less frequently than the other three purposes (binomial test 1%

[49] Some participants also completed another task (a dictator game) in the experiment which is not part of this chapter (see Chapter 7). As this task did not affect the donation decision, the data was pooled.

significance). Overall, 33 % of the subjects do not make a donation at all. Table 6.1 contains the descriptive statistics of the donation distribution.

In the *NoInfo* treatment in which subjects did not obtain information about charity revenues, mean donation per participant is €5.56 and in the *Info* treatment in which subjects obtain this information, mean donation is €5.43 (compare Table 6.2). Interestingly, providing participants with this information neither has an impact on individual donations nor on the probability to select a certain charitable cause. However, it shifts donations *within* the group of subjects who obtained the information: €455 are donated to small organizations and €132 are donated to large organizations. On average, participants donate €8.92 to small organizations and €6.95 to large organizations; this difference, however, is not statistically significant.

Out of the 110 subjects who received the information and made a positive donation, 73% choose the small organization, and only 27% choose the large organization. Thus, the shift of donations occurs mainly because small organizations are selected more frequently than large organizations (binomial test 1% significance). This effect is observed for all charitable causes (at least 5% significance each) as illustrated in Figure 6.1. The preference for small organizations appears to be very pronounced in the case of disabled care: Here, 86% of donors choose the small organization and 14% choose the large one. In case of development aid (medical research, animal protection), 68% (64%, 69%) of donors select the small organization.

The theoretical part in Section 6.2 proposes different explanations why people may prefer small organizations to large ones. However, one cannot be sure whether these reasons actually induced the subjects to choose the small organization. There are several other possible reasons for people's preferences which are not captured by the theoretical models. For example, small organizations might be associated with more local activities.

For this reason, an ex-post online survey was conducted with the subjects who participated in the *Info* treatment. The survey was completely anonymous and contained questions about the decisions in the experiment, namely (i) whether subjects donated a positive amount, if so (ii) to which charitable cause, (iii) to a small or a large organization, and given that choice (iv) for what reason they chose the small or the large organization. All questions offered predetermined answers including the option "I cannot remember". If participants had chosen the small organization, they were

provided with the following answers: "For my decision to donate to the small organization, it was decisive that (a) my donation to the small organization has a higher impact compared to a large organization, (b) small organizations are discriminated against compared to large ones and therefore need more support, (c) small organizations have lower administrative costs compared to large ones and therefore my donation is more likely to benefit the actual charitable cause, (d) small organizations are more likely to act on a local level compared to large ones, (e) small organizations are more specialized in certain fields of activity compared to large ones, (f) other reasons." If participants had chosen the large organization, they were provided with these options: "For my decision to donate to the large organization, it was decisive that (a) the large organization was able to already collect many funds (consisting of donations, membership fees and public subsidies), (b) large organizations can achieve more with my donation than the small ones, (c) large organizations have a higher level of familiarity compared to small ones, (d) large organizations are more likely to act professionally compared to small ones, (e) other reasons." In both cases, the predetermined options randomly varied between participants, they could select several options and give further reasons in an open description field.

Out of the 104 individuals who were invited to the survey 81 individuals took part.[50] The statements made in the survey are consistent with the observed behavior in the experiment, i.e. there are no significant differences between the survey data and the experimental data. For example, the 68% of responders stating in the survey that they donated a positive amount correspond to 64% who in fact donated a positive amount in the experiment. Let us first consider the people who had chosen the small organization. The reasons for this decision which are mentioned most frequently are lower administrative costs (50%) and a possible higher impact of the own donation (44%). Recall that these are the motives that are captured by the impact theory. Another reason which is mentioned frequently is the neediness of small organizations (39%), indicating the existence of a crowding out effect at the organizational level (see Figure 6.2).

[50] As an incentive to participate, everyone who completed the survey took part in a drawing for 5 times 30 Euros. A few people completed the survey via mail because they did not provide an email address. Six participants in the *Info* treatment were not invited to the survey because they did not provide any contact details.

Regarding the choice of the large organization the most frequently stated reason is the professionalism of large organizations (86%) followed by the effective achievement of objectives (43%) and the apparent ability to acquire funds (29%). All these motivations support the quality signaling approach. However, this signal appears to attract only few donors.

6.4.2 Effects of socio-demographic variables

After looking at the effects of the experimental treatments, this section presents econometric estimations analyzing the impact of various socio-demographic variables which have been surveyed in the questionnaire. Around 33% of the subjects decided not to donate, hence there is a large number of observations clustered at zero donations. In this case, ordinary least squares estimates would not be accurate, so a maximum likelihood estimation of a Tobit model was conducted. The baseline estimation includes the following socio-demographic variables: *age*, *household size* as the absolute number of household members including children, dummy variables for *male* subjects, *unmarried* subjects, subjects not having any religious affiliation (*no religion*), voters of the *left party*, highly educated subjects (*education*, owning a graduate degree), high *income* subjects (monthly net household income of 2.000 € or more).

It is very likely, however, that there are unobservable features influencing the donation decision. Therefore, additional estimations include four attitudinal variables taken from the German General Social Survey (ALLBUS) to control for one's perceived standing within society and the attitude towards the state. More precisely, the variable *position* is a dummy variable for subjects thinking they receive their fair share or more compared to others living in Germany. The variable *disparities* is coded as '1' for those subjects believing that the social disparities in Germany are just. The variable *state resp* is a dummy for subjects who want the state to care for a good living in case of illness, misery, unemployment and old age. Similarly, the variable *equalize* takes the value '1' if a subject indicated that it is the responsibility of the state to reduce income disparities. Although it is quite common to include attitudinal variables in econometric estimations (e.g. Corneo and Grüner 2002), the causality between these variables and the dependent variable (donations) may run in both directions, i.e. these variables may be endogenous. For this reason, Table 6.3 displays both estimations with attitudinal variables and those

without these variables in order to show whether effects are robust to this modification. The second specification furthermore includes a dummy variable for subjects that already made a charitable donation in the year 2009 (*donor 2009*) in order to control for offsetting effects. Furthermore, both estimations are presented with and without outliers. Outliers were defined as those subjects contributing more than half their endowment (€20) in the donation decision (five subjects).

The estimation results show a positive and highly significant effect of age on charitable donations, whereas the coefficients for male donors and household size are not significant. This finding is robust across all four models. Moreover, across all four estimations, voters of the left party on average give significantly smaller amounts than all other subjects. Surprisingly, being unmarried affects the donation decision positively and significantly. It may be suspected that unmarried subjects, as they may have less responsibility for other people in their everyday life, feel more obliged to help others with their donation.

Subjects without a religious affiliation make lower contributions, but the corresponding coefficient is only significant when outliers are excluded. As expected from previous empirical investigations, high income and high education both have a positive impact on donations although the significance levels vary according to the estimation specification. The relation between donations in the experiment and donations that have been made in the year 2009 previously to the experiment is, as expected, negative, though not significant. Furthermore, the attitudinal variables do not have any explanatory power.

Table 6.4 presents the results from a Probit estimation model with the dependent variable being '1' if a person donated a positive amount and '0' if a person did not donate. The results basically confirm the findings presented in Table 6.3. The probability to donate significantly increases with age. People without religious affiliation and left party voters are less likely to donate than others. Unmarried people are more likely to donate but this effect is statistically weak and depends on the specification of the estimation. Interestingly, the variables *education* and *income* are not significant in this estimation model. Thus, while high education and high income have a positive effect on the donation amount, they do not significantly increase the probability to donate.

We have seen that small organizations are preferred by the donors and certain characteristics influence the donation behavior differently. In a further step we now have a closer look at whether subjects' characteristics differ with respect to the choice of the organization. As there are three possible outcomes (no donation, donation to a small organization and donation to a large organization), a multinomial response model is appropriate. Presuming that adding another donation category, e.g. a medium sized organization, affects the donation decision of donors and non-donors differently, the assumption of the irrelevance of independent alternatives does not hold. Therefore, a nested logit model is used. In particular, two nests are defined in which one nest consists of all non-donors of the *Info* treatment while the other nest contains all donors that donated to either a small or a large organization. The outcome 'small organization' is used as baseline as it was selected most frequently by the subjects. The estimations include the same explanatory variables as in the first specification of Tables 6.3 and 6.4. The earlier defined outliers are included in the analysis as the decision to donate or not to donate is now the major point of interest (rather than the size of the donation). Moreover, the results do not change if the outliers are excluded.

The results presented in Table 6.5 show that donors who donate to a small organization do not significantly differ from donors who donate to a large organization (column 2). When comparing the donors to the small organization with the non-donors (column 1), we see that donors to small organizations are more likely to be unmarried than the non-donors ($p<0.1$). This result confirms the findings reported earlier in Table 6.3.[51]

6.5 Conclusions

This chapter's experiment contributes to the understanding how the provision of information about charities' revenues affects individual donation decisions. The results show that donors prefer to give to small charities with relatively low revenues as compared to large charities. Thus, the results support the models that predict a negative relation between a charity's income and the willingness to donate to that charity: the theory of impact philanthropy by Duncan (2004) which assumes that donors try to

[51] We also investigated in how far personal characteristics influence the choice of the charitable cause differently. The results turn out to be insignificant: A nested logit model shows that subjects who donated to disabled care do not have significantly different characteristics compared to people who donate to development aid, medical research or animal protection.

achieve the biggest impact possible with their charitable contribution and the public goods models, which predict incomplete crowding out of voluntary contributions by third-party contributions. The survey data shows that Duncan's model, in particular, captures motives that play an important role for real donation decisions. The quality considerations as suggested by Vesterlund (2003) and Andreoni (2006) play a role only for those few donors that chose to give to large organizations.

The type of information that was announced in the experiment differs from that used in other experiments: To the best of our knowledge, this is the first study which provides participants with the information about a charity's entire revenues. This kind of information is deemed to be more realistic because in real-life donation decisions, individuals usually do not precisely know whether and how much other individuals have given and to which extent a charity is subsidized by government. While the announcement of other individuals' contributions is likely to lead to the emergence of anchor points or the desire to comply with own or others' expectations, the information provided in this experiment does not point in one specific direction but rather offers two charities of different size. Considerations like signaling of wealth (Glazer and Konrad, 1996) or social approval (Holländer, 1990) are not relevant in the anonymous setting. Thus, varying the content of (social) information can be a fruitful area of further research. Furthermore, the experimental results indicate that small and large charities may converge over time as supporting small organizations seems to be more popular. The next step would be to test this hypothesis and to analyze drivers which were removed in the experiment but may counter this development in reality, such as reputation and search costs.

The results of the experiment confirm previous findings that the individual donations increase with subjects' age, income, and education (e.g. Pharoah and Tanner 1997, Schervish and Havens 1997). This suggests that donation decisions in the experiment are a good indicator of real-life decisions. Unmarried individuals donate significantly more and voters of the left party donate significantly less than others. As individuals with certain characteristics are more likely to react positively when provided with the opportunity to make a donation, fundraisers may be able to increase donations by specifically targeting those individuals.

6.6 Appendix

6.6.1 Tables

Table 6.1: Descriptive statistics

	Observations	Share in %	Total donation (in €)	Average donation (in €)
No donation	74	33	0	0
Donation	149	67	1,225	8.22
Disabled care	47	21	448	9.53
Development aid	39	17	318	8.15
Medical research	38	17	274	7.21
Animal protection	25	11	185	7.40
Total	223	100	1,225	5.49

Table 6.2: Descriptive statistics across treatments

	Observations	Share in % by treatment	Total donation (in €)	Average donation (in €)
NoInfo treatment	113	100	628	5.56
No donation	35	31	0	0
Donation	78	69	628	8.05
Info treatment	110	100	597	5.43
No donation	39	36	0	0
Small organization	51	46	455	8.92
Large organization	19	17	132	6.95
Total	223	100	1,225	5.49

Table 6.3: Tobit estimation results

	Including outlier		Excluding outlier	
Variables	(1)	(2)	(3)	(4)
_cons	-11.27***	-9.088*	-5.904*	-5.685
	(-2.671)	(-1.931)	(-1.782)	(-1.532)
age	0.232***	0.236***	0.170***	0.183***
	(3.760)	(3.780)	(3.461)	(3.648)
male	-1.563	-1.658	-0.773	-1.083
	(-1.094)	(-1.147)	(-0.689)	(-0.950)
household size	-0.00620	-0.125	-0.298	-0.461
	(-0.00738)	(-0.147)	(-0.451)	(-0.686)
unmarried	6.419***	5.893***	4.193***	4.099**
	(3.201)	(2.939)	(2.646)	(2.572)
no religion	-1.279	-1.200	-3.179**	-3.120**
	(-0.812)	(-0.762)	(-2.522)	(-2.457)
left party	-9.109***	-9.315***	-6.822***	-6.611***
	(-2.996)	(-2.996)	(-2.899)	(-2.747)
education	3.991***	3.962**	2.187*	2.271*
	(2.622)	(2.593)	(1.834)	(1.890)
income	4.695***	4.614***	3.357**	3.353**
	(2.722)	(2.675)	(2.480)	(2.470)
donor 2009		-2.194		-1.369
		(-1.333)		(-1.058)
position		0.0959		-0.301
		(0.0621)		(-0.248)
disparities		0.988		1.730
		(0.605)		(1.349)
state resp		-2.541		-0.212
		(-1.411)		(-0.145)
equalize		1.100		-0.467
		(0.748)		(-0.398)
No. of observations	189	189	184	184
LR Chi²	44.53***	49.09***	39.95***	43.39***
Pseudo R²	0.0418	0.0460	0.0414	0.0450

Notes: t-statistics in parentheses. Estimations (3) and (4) exclude outliers.
Levels of significance: * 10%, ** 5%, *** 1% significance.

Table 6.4: Probit estimation results

	Including outlier		Excluding outlier	
Variables	(1)	(2)	(3)	(4)
Constant	-0.375	-0.364	-0.292	-0.338
	(-0.620)	(-0.528)	(-0.479)	(-0.487)
age	0.0191**	0.0216**	0.0185*	0.0215**
	(2.018)	(2.181)	(1.935)	(2.142)
male	-0.165	-0.226	-0.161	-0.233
	(-0.807)	(-1.066)	(-0.784)	(-1.089)
household size	-0.0639	-0.0913	-0.0750	-0.102
	(-0.542)	(-0.740)	(-0.630)	(-0.825)
unmarried	0.512*	0.486*	0.484*	0.471
	(1.778)	(1.647)	(1.660)	(1.576)
no religion	-0.399*	-0.406*	-0.460**	-0.477**
	(-1.836)	(-1.835)	(-2.083)	(-2.117)
left party	-1.071***	-1.068***	-1.047***	-1.037***
	(-2.858)	(-2.718)	(-2.787)	(-2.636)
education	0.314	0.339	0.274	0.298
	(1.414)	(1.484)	(1.230)	(1.302)
income	0.217	0.233	0.178	0.190
	(0.855)	(0.900)	(0.696)	(0.728)
donor2009		-0.303		-0.298
		(-1.260)		(-1.229)
position		-0.0341		-0.0528
		(-0.152)		(-0.234)
disparities		0.322		0.347
		(1.306)		(1.390)
state resp		-0.0412		0.0430
		(-0.152)		(0.155)
equalize		-0.00234		-0.0685
		(-0.0110)		(-0.315)
No. of observations	189	189	184	184
LR Chi^2	22.77***	26.36**	21.97***	25.83**
Pseudo R^2	0.0964	0.1116	0.0946	0.1112

Notes: z-statistics in parentheses. Estimations (3) and (4) exclude outliers.
Levels of significance: * 10%, ** 5%, *** 1% significance.

Table 6.5: Nested logit estimation results

Variable	(1) No organization	(2) Large organization
age	-0.011	0.046
	(0.013)	(0.042)
male	0.068	-0.587
	(0.613)	(1.251)
household size	0.357	0.409
	(0.363)	(0.912)
unmarried	-1.008*	1.227
	(0.559)	(1.386)
no religion	-0.571	-3.242
	(1.169)	(2.679)
left party	-3.119	-5.259
	(2.902)	(4.168)
education	-1.155	1.239
	(0.708)	(1.573)
income	-0.649	0.028
	(0.781)	(1.666)
No. of observations	279	279
Wald test: Prob > chi2 = 0.5375		
LR test for IIA: Prob > chi2 = 0.0931		

Notes: base variable: small organization.
Standard errors in parentheses.
Levels of significance: * p<0.10, ** p<0.05, *** p<0.01.

Table 6.6: Socio-demographic characteristics of participants – Part I

Variable	State	Frequency abs.	Frequency in %
Gender	Male	103	46.19
	Female	119	53.36
	No answer	1	0.45
Age	18 – 29	73	32.74
	30 – 44	60	26.91
	45 – 59	54	24.22
	60 – 75	34	15.25
	No answer	2	0.90
Family Status	Single	139	62.33
	Married	45	20.18
	Divorced	31	13.90
	Widowed	6	2.69
	No answer	2	0.90
Children	Yes	34	15.25
	No	189	84.75
Household size	1	102	45.74
	2	82	36.77
	3	21	9.42
	4 or more	17	7.62
	No answer	1	0.45
Education	University	88	39.46
	Gymnasium (12 years of education)	58	26.01
	Realschule (10 years of education)	35	15.70
	Hauptschule (9 years of education)	23	10.31
	Other	17	7.62
	No graduation	2	0.90
Nationality	German	192	86.10
	Turkish	2	0.90
	Italian	3	1.35
	Polish	2	0.90
	Other	23	10.31
	No answer	1	0.45
	Σ	223	100.00

Table 6.7: Socio-demographic characteristics of participants – Part II

Variable	State	Frequency abs.	Frequency in %
Household net income	< 1,000 €	51	22.87
	1,000 – 2,000 €	85	38.12
	2,000 – 3,000 €	44	19.73
	3,000 – 4,000 €	13	5.83
	4,000 – 5,000 €	8	3.59
	> 5,000 €	8	3.59
	No Answer	14	6.28
Religion	Catholic	70	31.39
	Evangelic	71	31.84
	Muslim	5	2.24
	Other	10	4.48
	No religion	67	30.04
Voting behavior	The Christian Democratic / Christian Social Union	43	19.28
	The Social Democratic Party	49	21.97
	The Greens	42	18.83
	The Free Democratic Party	25	11.21
	The Left Party	17	7.62
	Other	9	4.04
	Nonvoter	17	7.62
	No answer	21	9.42
	Σ	223	100.00

Table 6.8: Charitable giving habits of participants

Variable	State	Frequency abs.	Frequency in %
Donated before	Yes	189	84.75
	No	34	15.25
Modal charitable purpose[1]	Child or disabled care	46	20.63
	Emergency aid	12	5.38
	Medical research	13	5.83
	Church and religious purposes	11	4.93
	Environment or animal protection	32	14.35
	Development aid	39	17.49
	General (e.g. Red Cross, charitable lotteries)	20	8.97
	Culture	3	1.35
	Politics	2	0.90
	Local welfare services, homeless persons, poverty	8	3.59
	No answer (incl. 34 subjects who did not donate before)	37	16.59
Contribution receipt received	Always	60	26.91
	Mostly	36	16.14
	Sometimes	42	18.83
	Never	49	21.97
	No answer (incl. 34 subjects who did not donate before)	36	16.14
Donated in 2009	Yes	67	30.04
	No	156	69.96
	Σ	223	100.00

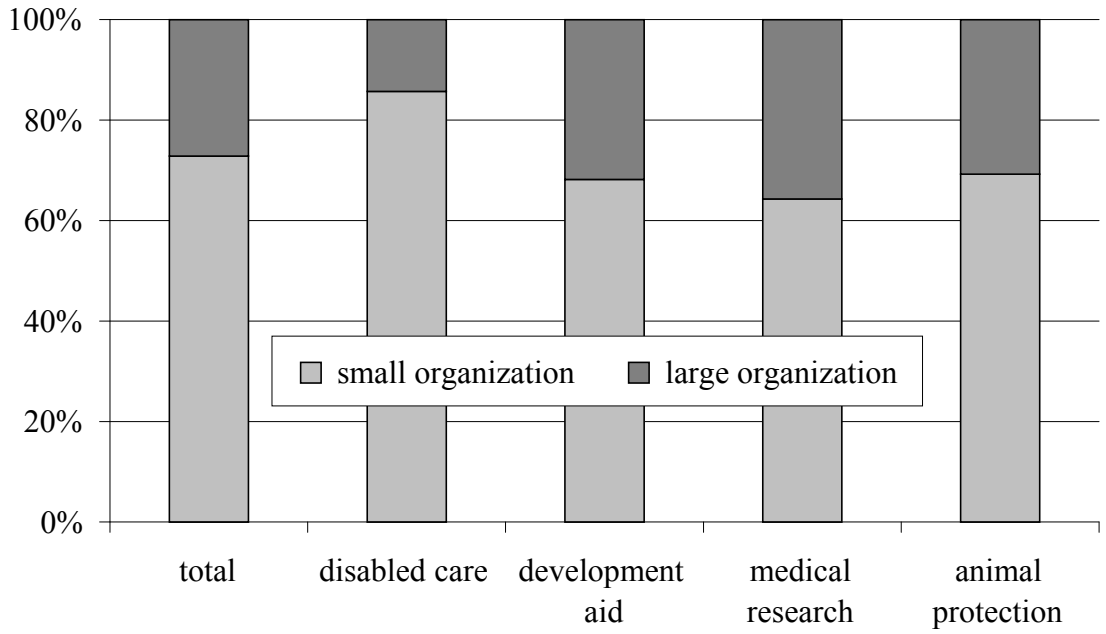
[1)] If subjects stated that they have donated before they were asked to which charity they donated most frequently. If subjects gave more than one answer the charity named first was included.

Table 6.9: Attitudes of participants

Question / Statement	Answer	Frequency abs.	Frequency in %
Compared with how others live in Germany: Do you think you get your fair share, more than your fair share, somewhat less or very much less than your fair share?	Very much less	20	8.97
	Somewhat less	61	27.36
	Fair share	104	46.64
	More than fair share	19	8.52
	Don't know	19	8.52
All in all, I think the social differences in this country are just.	Completely agree	14	6.28
	Tend to agree	65	29.15
	Tend to disagree	90	40.36
	Completely disagree	50	22.42
	Don't know	4	1.79
It is the responsibility of the state to meet everyone's needs, even in case of sickness, poverty, unemployment and old age.	Completely agree	74	33.18
	Tend to agree	104	46.64
	Tend to disagree	35	15.70
	Completely disagree	4	1.79
	Don't know	6	2.69
It is the responsibility of the government to reduce the differences in income between people with high incomes and those with low incomes.	Strongly agree	32	14.35
	Agree	73	32.74
	Neither agree nor disagree	39	17.49
	Disagree	48	21.52
	Strongly disagree	17	7.62
	Can't choose, don't know	14	6.28
	∑	223	100.00

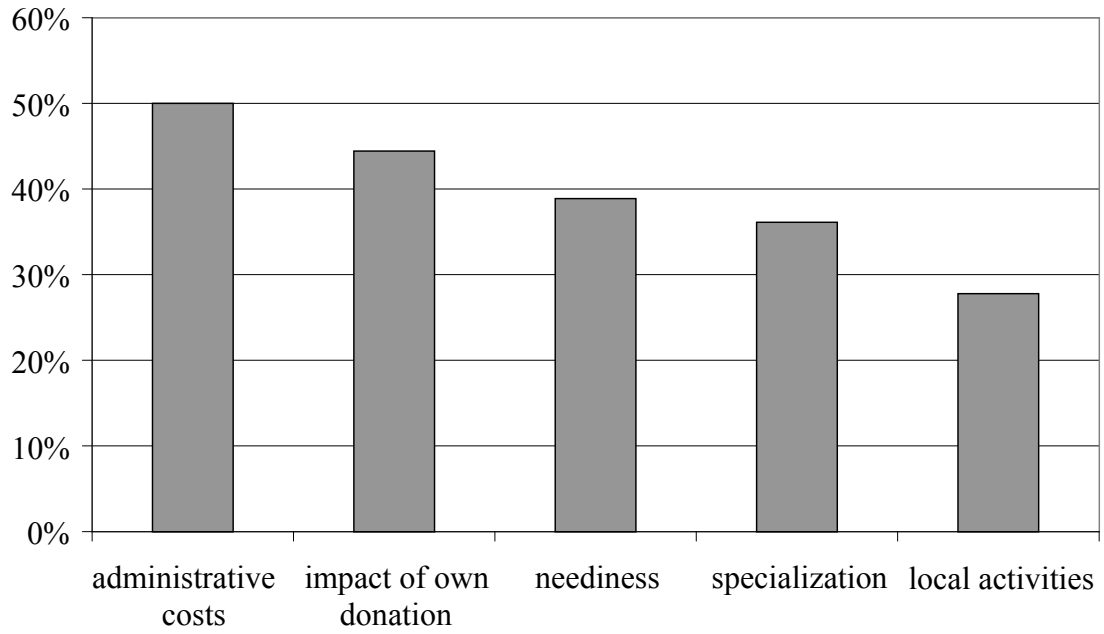
6.6.2 Figures

Figure 6.1: Selection of organization size



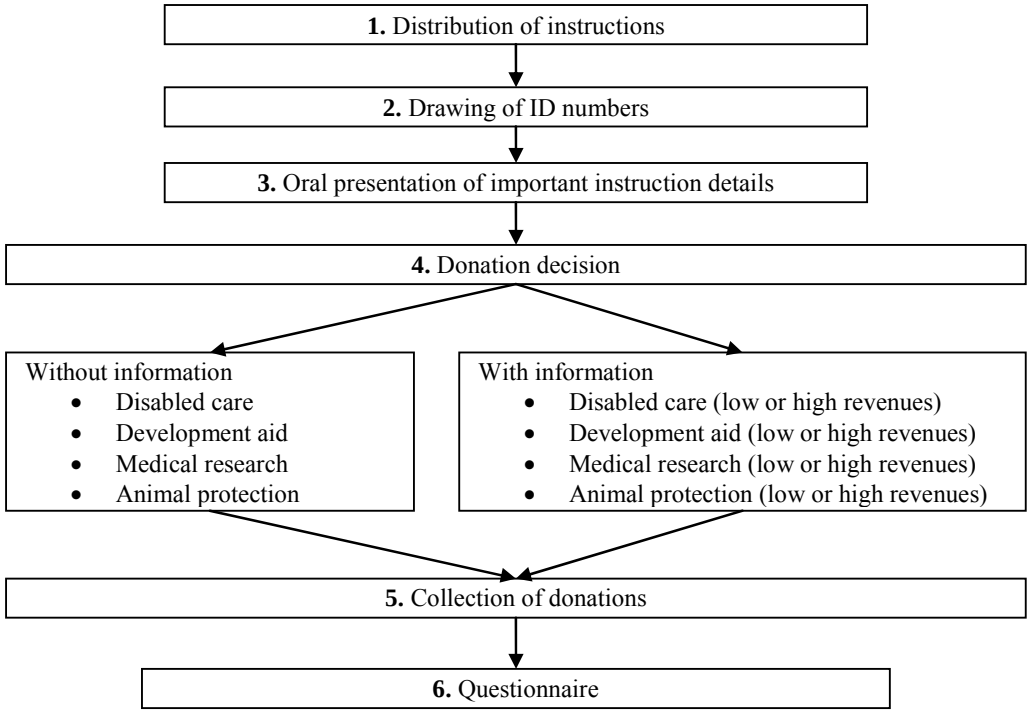
Note: Selection of organization size in the *Info* treatment [in % of donors].

Figure 6.2: Reasons to choose the small organization



Note: in % of donors.

Figure 6.3: Proceeding of the experiment



Note: The treatments with information are identical to the treatments without information except for the fact that in the donation stage subjects could choose between a small organization (with revenues between €40,000 and €300,000) and a large organization (with revenues between €5 million and €11 million) for each charitable purpose.

6.6.3 Experimental instructions

Experimental instructions for the *Info* treatment (translated from German)

Welcome!

Thank you very much for participating in our study for the analysis of consumer behavior. Enclosed in this folder, you find information which you need during this event. You may return pages to which you have already gone through at any time. Please turn pages only up to the next 'stop-sign'. You will be asked to turn to the next page. Please only read the respective text and do not act until you receive specific instructions to follow the assignment.

Please follow the instructions carefully. We also would like to ask you not to talk to other participants.

We want to emphasize that all information which we gain from today's event will only be used to draw a comparison between the groups of participants. No individual data about the participants will be published or passed on.

Shortly, we will come up to your seat and you will draw a piece of paper with a number on it. This number will serve as your personal identification number (ID) throughout the study. Please state your ID whenever you are asked to do so during the study. The ID ensures anonymity, as neither other participants nor we know your name or the ID that belongs to it.

-- STOP sign: Please do not turn the page until we ask you to! --

Part 1

For your participation in the study, you will receive 40 Euros. Shortly, we will hand out the money in an envelope. Then we ask you to confirm the receipt. Afterwards, you will get the opportunity to donate any preferred amount of money to a charitable cause.

There is a charitable organization behind every charitable cause. The money which you, if any, will donate, will be **completely** transferred to the respective charity. We guarantee that this will happen lawfully and will have the transfer supervised and verified by the director of the notary's office, Dr. Rainer Preusche.

All selected charitable organizations hold the 'donation seal' by the state-approved German Central Institute for Social Issues (Deutsches Zentralinstitut für soziale Fragen (DZI)). This assures that the organizations act autonomously and charitably and that the usage of their financial means is reviewable, economical and statutory. The names of the individual organizations will at this point – for scientific reasons – not be mentioned. We guarantee that all information you receive from us regarding the organizations is **true**. At the end of the experiment, we are happy to hand to you a list of all organizations upon request.

Following, we present to you four different charitable causes to which you can donate in the course of this study.

The four charitable causes are:

- Medical research
- Animal protection
- Disabled care
- Development aid

[*Additional part mentioned only in the Info Treatment*:

The organizations you can make a donation to do not only differ with regard to their charitable causes, but also their **revenues**, which these organizations have generated in 2006 from donations, membership fees and government grants. For each charitable cause, we offer you a charitable organization with relatively small revenues between 40,000 and 300,000 Euros and organizations with rather large revenues between 5 million Euros and 11 million Euros.

Therefore, we ask you, in the case you donate, to pick **one** of the following organizations:

a. Medical research Revenues 2006: 40,000€ - 300,000€

b. Medical research Revenues 2006: 5 Mio. € - 11 Mio. €

c. Animal protection Revenues 2006: 40,000€ - 300,000€

d. Animal protection Revenues 2006: 5 Mio. € - 11 Mio. €

e. Disabled care Revenues 2006: 40,000€ - 300,000€

f. Disabled care Revenues 2006: 5 Mio. € - 11 Mio. €

g. Development aid Revenues 2006: 40,000€ - 300,000€

h. Development aid Revenues 2006: 5 Mio. € - 11 Mio. €]

We now hand out to you an envelope with the money you receive for your participation in our study.

-- STOP sign: Please do not turn the page until we ask you to! --

In the envelope, you find:

- one white envelope
- one blue envelope
- 40 Euros, composed of two 10 Euro-bills, one 5 Euro-bill, six 2 Euro-coins and three 1 Euro-coins
- one receipt.

We now ask you to sign the receipt you find enclosed. By doing so, you confirm that you have received 40 Euros from ZEW for the participation in this study. We need the receipt for administrative purposes. Without a receipt we are not allowed to give you the money. Your data is still handled **confidentially** and **anonymized**. We will now collect the receipts, the study will continue hereafter.

-- STOP sign: Please do not turn the page until we ask you to! --

Now you can make a donation decision. You can decide **freely and anonymously** whether and how much money you want to give to one of the above-mentioned charitable organizations. The amount of money you put into the **blue** envelope will benefit a charitable cause and will be transferred **completely** to the respective charity after the experiment. You will keep the amount of money you put into the **white** envelope.

The study proceeds as follows:

1.) Make your donation decision.

In case of a donation, please tick the desired charitable organization on the **blue** envelope. Please note that you have to choose **one** of the four [*in the Info treatment*: eight] charities given. It is not possible to choose more than one charitable organization for your donation. Please tick only **one** organization if you wish to donate. If you tick more than one organization, unfortunately, we will not be able to transfer the donation. If you do not wish to donate, please do not tick any organization.

2.) Write down your ID-number into the predefined box on the **blue** envelope, irrespective of whether you wish to donate or not.

3.) Put the desired donation amount into the **blue** envelope.

4.) Put the amount of money you wish to keep into the **white** envelope.

Finally, you should have distributed 40 Euros completely to the two envelopes. Please note that any distribution in full amounts of Euros is possible. You may put any desired amount of money into both envelopes. It is also possible to put 40 Euros completely into one envelope.

5.) Seal up **both** envelopes.

When all participants have finished, we will come up to you and collect the **blue** envelope. When we do so, please put the **blue** envelope into the box. Please keep the white envelope. We guarantee that your donation will be transferred to the charitable organization lawfully and have the transfer supervised and verified by the director of the notary's office, […].

We will explain the most important items once again orally. Afterwards, please make your decision as described above.

-- STOP sign: Please do not turn the page until we ask you to! --

Part 2 – Questionnaire

Please answer the following questions by ticking or filling out.

If you have a question, please raise your hand. We will come up to you and answer your question. Please do **not** say your question out loud and please do not talk to other participants.

1. What is your ID-number? _____

2. How can your marital status be described?

- O unmarried
- O married
- O divorced
- O widowed

3. Please state your gender:

- O male
- O female

4. What is your year of birth? _____

5. How many people, including you, live in your household?

_____

6. How many children live in your household?

- O 0-3 years old _____
- O 4-7 years old _____
- O 8-12 years old _____
- O 13-18 years old _____
- O older than 18 years _____

O none

7. What is your religious affiliation?

O Catholic
O Protestant
O Muslim
O Jewish
O Buddhist
O other: _____
O no religion

8. What is your highest educational achievement?

O University/College
O higher education entrance qualification
O middle school
O secondary modern school
O other: _____
O none

9. What is your original nationality?

O German
O Turkish
O Italian
O Polish
O other: _____

10. What is your first language? _____

11. What are the monthly net earnings of your household (how much money per month is available for your household altogether?)

O below 1,000 Euros
O 1,000 – 2,000 Euros
O 2,000 – 3,000 Euros
O 3,000 – 4,000 Euros
O 4,000 – 5,000 Euros
O above 5,000 Euros
O not specified

12. Which party would you vote for if there were federal elections on the coming Sunday?

O CDU/CSU
O SPD

O Bündnis 90 / The Green Party

O FDP

O The Left

O Other

O I do not vote

O not specified

14. Have you made a donation to a charitable organization before?

O yes O no

15. To which purpose have you to date donated most often?

_____

16. Have you already donated this year to a charitable organization?

O yes O no

17. If you answered question 16 with 'yes', in which month have you donated last?

_____

18. If you answered question 16 with 'yes', how much have you donated this year altogether?

_____ €

19. Have you ever received a donation receipt for your donation?

O always

O mostly

O occasionally

O never

20. Compared with how others live in Germany: Do you think you get your fair share, more than your fair share, somewhat less or very much less than your fair share?

O fair share

O more than fair share

O somewhat less than fair share

O very much less than fair share

O don't know

21. On the whole, I find the social differences in our country just.

O Completely agree.

O Tend to agree.

O Tend to disagree.

O Completely disagree.

O Don't know

22. The State must ensure that people can live a decent income even in illness, hardship, unemployment and old age.

- O Completely agree.
- O Tend to agree.
- O Tend to disagree.
- O Completely disagree.
- O Don't know

23. It is the responsibility of the government to reduce the differences in income between people with high incomes and those with low incomes.

- O Agree strongly.
- O Agree.
- O Neither agree nor disagree.
- O Disagree.
- O Disagree strongly.
- O Can't choose.

-- STOP sign: Please do not turn the page until we ask you to! --

We would like to ask you to write down general comments regarding our study. You *may* also give reasons for your donation decision. [11 empty lines follow]

We would like to thank you for participating in our study and wish you a nice day! Please remember to take the white envelope with you.

7 On the construction of social preferences in experiments

7.1 Introduction

One of the most important questions in experimental economics is whether individual behavior in certain games is predictive for behavior in other games or contexts. Critics often claim that individual behavior in the lab is limited to that situation and does not contain much information about how people behave outside the lab. This question appears to be particularly relevant for other-regarding or social preferences, i.e. preferences which are not captured by the standard assumption of rational and purely payoff-maximizing agents and which have been largely investigated in the lab.

One important class of theories which has been developed to explain other-regarding behavior sticks to the assumption of rational agents but introduces an additional motive to the utility function. This set of theories includes, among others, the 'warm-glow' of giving (Andreoni 1989, 1990), inequity aversion (Fehr and Schmidt 1999, Bolton and Ockenfels 2000) and the desire to comply with social norms (Levitt and List 2007). In order to test the various theories of social preferences in the lab, experimental economists have developed a wide range of games, like for example the ultimatum game, the dictator game, the trust game or the public good game. It has been shown that a substantial share of experimental subjects does not act selfishly, but shares their endowment, rewards pro-social behavior and contributes to public goods. Still, the results of the experiments testing the *consistency* of social preferences across multiple games or multiple contexts are ambiguous (see Bolton et al. 2008 and the next Section 7.2 for examples).

The discussion about whether preferences are consistent or not goes back to Stigler and Becker (1977), who propose that tastes are stable over time and similar among people. Tversky and Kahneman (1981), in comparison, emphasize the importance of framing effects for shifts in individual preferences. There is also some empirical evidence that in certain situations preferences are constructed rather than existing. The constructive-preference approach (Lichtenstein and Slovic 2006) suggests that individuals construct preferences when they are confronted with an unfamiliar decision situation. Thus, the nature of the task, the information available and the situational context have a strong impact on preference construction. With more experience in a certain situation,

preferences are said to consolidate over time and become more stable (Hoeffler and Ariely 1999).

This chapter sheds light on this issue by investigating and comparing charitable donations and dictator game allocations in an experimental setting for a better understanding of what drives the decision in each task and whether behavior in one task is predictive of behavior in the other. The donation decision is a familiar decision situation where individuals are likely to have existing preferences. In contrast, the dictator game (Kahneman et al. 1986), though very simple, represents a rather unfamiliar decision situation for most subjects: It is hard to imagine real-life situations where one is asked to share a certain amount of money with a completely anonymous person. Therefore, it seems questionable that individuals have a well-defined set of existing preferences guiding their behavior in this game. Individuals faced with this game might rather construct their preferences ad hoc. Moreover, the dictator game has been shown to be relatively sensitive towards changes in the experimental setting: Methodological variables, such as anonymity and experimenter blindness, as well as structural variables, such as identity of recipients, communication, available action sets, entitlement to and information about the amount being divided, can have strong effects on the outcome (for an overview see Camerer 2003, List 2007).

Unlike many of the previous experiments, the present study uses within-subject as well as between-subject tests and pays special attention to the *sequence* in which the games are played as this becomes important, if preferences are indeed constructed. Furthermore, a non-student subject pool is used for two reasons: First, those subjects are unlikely to have played a dictator game before. And second, supposedly all of them have either donated to a charity or at least been asked for donations before. The experimental results show that there is a significantly positive correlation between both decision tasks if – and only if – the more familiar donation decision is presented first and the rather unfamiliar dictator game is played thereafter. Moreover, the dictator game allocations depend on the sequence of games while the charitable donations do not. Hence, social preferences elicited in the donation context are predictive of subsequent behavior in the dictator game but not vice versa. Thus, if experimenters try to elicit social preferences to make predictions about behavior in other contexts, it seems reasonable to confront individuals with context-rich familiar decision situations where preferences exist and do not need to be constructed. Furthermore, special attention

should be paid to the sequence of games if they present a new decision situation for the experimental subjects. The outline of this chapter is as follows: Section 7.2 presents empirical findings from related studies. Section 7.3 describes the experimental setting and Section 7.4 delivers the results. The last Section 7.5 concludes.

7.2 Empirical findings

Looking at the findings from earlier empirical work, the question whether social preferences measured in lab experiments, and particularly in dictator games, are predictive of behavior in other games or other contexts, is still largely open. There are three different types of studies which are related to present approach.

First, several lab experiments use (modified) dictator games to measure individual social preferences and relate the observed behavior to the performance in a different game by means of within-subject tests (e.g. Ashraf et al. 2006, Blanco et al. forthcoming, Brosig et al. 2007, Teyssier 2009). The experimental results are not coherent, thereby indicating that dictator game behavior is not reliably predictive of behavior in other games. All the listed studies use context-free games and test theories of other-regarding behavior.

The second branch of literature deals with the consequences of *context* for decision making within economic experiments. These studies aim at comparing dictator game allocations with charitable donations (e.g. Eckel and Grossman 1996, Bettinger and Slonim 2006). They generally find that people give more to charities than to peers in a dictator game. Similarly, Brañas-Garza (2006) shows that dictators are more generous if they are informed that their recipients are poor compared with the behavior if not provided with this information. This branch seems to have the greatest similarity to our approach; however, they do not consider the *correlation* between games, i.e. whether the people who are generous in the dictator game are more likely to donate to charities.

The third class of studies does consider the correlation between games but focuses on social dilemma games rather than dictator games. More precisely, the studies compare behavior in context-free social dilemma games with contributions to naturally occurring public goods using within-subject tests (e.g. Laury and Taylor 2008, de Oliveira et al.

2008). The experimental results indicate that cooperative behavior across multiple contexts tends to be consistent, albeit the relation is not always incontrovertible.[52]

The focus of all studies mentioned above lies on the comparison of behavior across multiple games or multiple contexts, so the effects of *sequence* are of minor interest. Although some of the studies control for sequence effects by changing the order of the games, and some of these indeed find effects, none of them really dwell on those effects. This study narrows this gap as subjects have to make both charitable donation decisions and decisions in a conventional dictator game. In doing so, the order of play is changed to examine whether or not preferences are robust to this modification, thereby indicating if they are existent or constructed.

7.3 Experimental design

7.3.1 Participants and implementation

For subject recruitment, invitation letters were randomly distributed in the city of Mannheim, Germany. The letter contained an invitation to take part in a scientific study and informed people that they would receive €40 for participation. It was announced that there would be a survey in which they could (voluntarily and anonymously) make consumption decisions. We used this relatively high show-up fee in order to avoid underrepresentation of people with high opportunity costs of time. The experiment took place in July 2009 on the premises of the Centre for European Economic Research (ZEW) in Mannheim with a total of 223 participants. At the beginning of each session, participants individually drew lots to determine their ID number – which remained unknown to other participants and the experimenters – and chose a table. The tables had privacy screens on every side to ensure private decisions and answers. Participants were not allowed to talk to each other. If they had questions, the experimenters answered them privately. The 12 experimental sessions lasted around 60 minutes each. Within one session, all subjects performed exactly the same task. At first, all participants obtained detailed instructions about the course of the experiment (see Section 7.6.3 for experimental instructions). The main features were orally repeated. It was emphasized

[52] A fourth branch of literature tests whether individual other-regarding behavior in the lab and in the field correlates (e.g. Benz and Meier 2008, Fehr and Leibbrandt 2008, Carpenter and Myers 2010), which is often the case.

that any information given in the instructions was true. Participants in all treatments filled out a questionnaire about socio-demographic characteristics and donation habits. At the end of each session, participants also had the chance to comment on the experiment and give reasons for their decisions.

Participants' socio-demographic characteristics and donation habits are shown in Tables 7.4 and 7.5. Although the subject pool is not fully representative of the German resident population, it is sufficiently diversified in all socio-demographic variables in order to examine the influence of each variable on charitable donations and dictator game allocations. The vast majority of participants (84.8%) had previously donated to a charity. The most common charitable purposes were child care and disabled care followed by development aid and environment or animal protection. This underlines that most experimental subjects show some kind of experience regarding the donation decision.

7.3.2 Treatments

The experiment comprised three treatments. Each treatment contained a real donation stage where subjects simultaneously and independently decided how much – if any – of their endowment they want to donate to a certain charity. All of the selected charities have obtained the 'DZI Spendensiegel', a label for charities which use their funds economically and according to their statutes.[53] Subjects could choose one of four charitable purposes, namely disabled care, development aid, medical research or animal protection and they only knew the purpose but not the name of the organizations.[54] All donation decisions were completely voluntary and anonymous. A double blind procedure was used in which neither other subjects nor experimenters came to know if, how much and to which purpose a subject donated. Subjects received a large envelope containing two smaller envelopes and the endowment of €40 broken into two 10-euro notes, one 5-euro note, six 2-euro coins and three 1-euro coins. This breakdown enabled subjects to donate any integer amount between €0 and €40 and reduced incentives to only give the coins. Subjects placed the amount they wished to donate in one of the

[53] For more information (in German language), see www.dzi.de (accessed in October 2010).
[54] Some of the participants also received information about the size of the charities. The effects of this information have been discussed in the previous Chapter 6. As there is no significant difference in donations between subjects who received the information and subjects who did not, the data was pooled.

small envelopes assigned to donations, labeled the envelope with their ID number and, in case they were willing to give a positive amount, the charitable purpose to which they wished to donate. The amount of money subjects wished to keep for themselves was placed in the other small envelope. Afterwards, subjects dropped the envelopes specified for donations in a box. All donations made during the experiment were transferred in full to the respective organizations. The counting of donations and the transfer to the organizations were monitored and certified by a notary. This procedure and the name of the notary had been announced in the experimental instructions.

The baseline treatment (*'NoDG'*) solely involved the donation stage and afterwards the completion of the questionnaire. Two treatments contained a conventional dictator game besides the donation stage. In those treatments, subjects received an additional endowment of €20. Subjects simultaneously and independently decided how much – if any – of this endowment they want to give to another participant. Recipients of this allocation were randomly selected from the *NoDG* treatment without dictator game. The procedure in the dictator game was the same as in the donation stage. Subjects did not get any information about the recipient except that the person participated in a different session and did not receive the additional €20. The dictator game decisions were completely voluntary and anonymous. Again, a double blind procedure was used in which neither other subjects nor experimenters came to know if and how much a subject allocated to the recipient. Subjects received a large envelope containing two smaller envelopes and the endowment of €20 broken into two 5-euro notes, two 2-euro coins, and six 1-euro coins. This breakdown enabled subjects to donate any integer amount between €0 and €20 and again reduced incentives to only give the coins.

Subjects placed the amount they wished to allocate to the recipient in one of the small envelopes and labeled the envelope with their ID number. The amount of money subjects wished to keep for themselves was placed in the other small envelope. Afterwards, subjects dropped the envelopes with the allocations to the recipients in a box. Subjects knew that these envelopes were given to randomly selected recipients even if the envelopes did not contain any money. In one dictator game treatment (*'DGStart'*), the dictator game was placed at the start of the session followed by the questionnaire and the donation stage. In the other dictator game treatment (*'DGEnd'*), sessions started with the donation stage, proceeded with the questionnaire and ended with the dictator game. Recipients in the treatments without dictator game obtained the

envelopes with the allocations from the dictators always at the end of the session.[55] Figure 7.3 shows the proceeding of the experiment. Table 7.1 summarizes the features of all treatments including number of sessions and number of subjects.

7.4 Results

7.4.1 Average patterns

In total, €1,225 are donated to the charitie.[56] On average, €5.49 (14% of the initial endowment of €40) are donated to the charities and €4.70 (23% of the initial endowment of €20) are allocated in the dictator game. Overall, 33% of the subjects do not make a donation and 27% of the subjects do not allocate anything in the dictator game. Table 7.2 summarizes the most important descriptive findings.

In the *DGStart* treatment, in which the dictator game is played at the beginning of the session, dictators allocate an average amount of €6.25. Allocations in the *DGEnd* treatment, in which the dictator game is played at the end of the session, are significantly lower: Here, dictators allocate €3.87 on average (Mann Whitney test, 1% significance). Figure 7.1 illustrates this difference: While only 10% of the dictators in *DGStart* do not allocate anything to an experimental peer, this percentage is much higher in the *DGEnd* treatment (36%). At the same time, the share of dictators who allocate at least €10 is twice as large in *DGStart* as in *DGEnd*. The average charitable donations made in the different treatments (€5.72 in *NoDG*, €6.25 in *DGStart* and €4.76 in *DGEnd*) do not significantly differ.

Why do dictators give less when this decision *follows* the donation decision? For a start, we suggest that an income effect might cause this observation. At the time of the dictator game decision, subjects in the *DGStart* treatment did not know that they would be asked for donations thereafter. In contrast, subjects in the *DGEnd* treatment had already made their donation at this stage, i.e. their remaining budget was smaller: While dictators in *DGStart* calculated with a total of €60, dictators in *DGEnd* calculated with €60 less the amount they had donated. If we take this into account and consider the

[55] Due to no-shows there were a few more dictators than recipients. The amount of money that these dictators allocated to recipients (overall €7) was transferred to a randomly selected charity.
[56] For selection of charitable purposes and average donation to each purpose see Section 6.4.1 in the previous chapter.

relative dictator game allocation, i.e. the chosen allocation relative to the budget principally available at this stage, we find that the differences are decreasing: Dictators in *DGStart* allocate an average 10% of the available budget and dictators in *DGEnd* allocate 8% on average. Notably, dictators in *DGStart* allocate a larger share of their available budget, although the €40 for participation are not yet on the table. The difference in relative allocations is still significant (Mann Whitney test, 5% significance), indicating that the income effect can only partly explain the difference in dictator game allocations between *DGStart* and *DGEnd*.

A similar reasoning applies to the donation decision. While subjects in *DGStart* calculated with €60 less their dictator game allocations, individuals in *DGEnd* calculated with €40 because they did not know that they would receive an additional €20 after the donation stage. Taking this into account, we find that in both treatments subjects donate an average 12% of their available budget to the charities. This percentage is not significantly different from the relative donations (14%) in the treatment without dictator game (Mann Whitney test).

7.4.2 Individual patterns

This section takes a closer look at individual patterns and compares individual behavior in both tasks. By applying Spearman's rank correlation test, we observe that in *DGEnd* dictator game allocations and donations are positively and significantly correlated (1% significance) while the positive correlation is not statistically significant in the *DGStart* treatment.

To shed more light on this observation, we define individual behavior as 'consistent' if a subject belongs to one of three categories: Subject's giving in *both* games (i) is zero, (ii) is below the respective median values[57] but non-zero in at least one decision task, or (iii) is equal to or greater than the respective median values. Given this classification, the probability of observing consistent behavior across games is significantly higher in *DGEnd* (75%) than in *DGStart* (63%) (binomial test, 5% significance), as can be seen from Figure 7.2. Figure 7.2 shows that 5% of the subjects in *DGStart* give nothing in

[57] The median values are calculated in relative terms for each group: (a) relative donations in *DGStart*, (b) relative donations in *DGEnd*, (c) relative DG allocations in *DGStart*, (d) relative DG allocations in *DGEnd*.

both decisions while the share in the *DGEnd* treatment is 25%. This difference, however, is almost leveled off by the subjects who contribute below the respective median value in both games but give a positive amount in at least one decision task. More consistent contributions above median are observed in the *DGEnd* treatment.

These findings about the consistency of individual behavior potentially provide an interesting feature of the elicitation of social preferences by means of simple experimental games. Our inexperienced subjects who play the dictator game at the beginning of the experiment face a new and unfamiliar decision situation. As they probably do not have existing preferences for this situation, they construct preferences ad hoc to reach a decision. For example, they may want to avoid extreme outcomes and, therefore, allocate a small or medium amount to an experimental peer rather than giving nothing. In contrast, if subjects face the dictator game decision after the more familiar donation decision, they may use the donation decision as an 'anchor' leading to a higher degree of consistency across games. As this anchor is not available when the dictator game is played first, individual behavior is less consistent. This result is an indication for how preferences may be constructed in an experiment. The constructive-preference approach may also explain why charitable donations are independent from the sequence of play, while the dictator game allocations are not.

7.4.3 Econometric analysis

In order to gain a further insight into the driving forces behind individuals' behavior in the donation decision and the dictator game, the impact of various socio-demographic variables is analyzed by conducting an econometric analysis. In both tasks, around one third of the participants chooses zero contributions. Hence, there is a large number of observations clustered at zero. In this case, ordinary least squares estimates would not be accurate, so a Tobit estimation model is used. The following socio-demographic variables are included in the regressions: *age*, *household size* as the absolute number of household members including children, dummy variables for *male* subjects, *unmarried* subjects, subjects not having any religious affiliation (*no religion*), voters of the *left party*, highly educated subjects (*education*, owning a graduate degree) and high *income* subjects (monthly net household income of €2.000 or more). In order to verify how the sequence of the tasks influences our results, a dummy variable *DGStart* is included which is coded '1' if the dictator game was played before the donation stage and '0' if it

was played afterwards. In specification (1) in Table 7.3 the dependent variable is the amount donated in the donation decision while in specification (2) the dependent variable is the amount allocated in the dictator game. Specifications (3) and (4) exclude outliers which are defined as those observations lying outside the donation or allocation interval of three standard deviations from the mean.[58]

First of all, the estimation results in Table 7.3 confirm the finding reported above: People choose higher dictator game allocations if they play the dictator game prior to the donation stage while donations are not significantly influenced by the order of the tasks. Comparing the results of specifications (3) and (4), we see that personal characteristics influence both contribution decisions similarly: While neither the donation nor the allocation decision is significantly affected by gender, religious affiliation, education and income, the variables age, family status and voting for the left party have the same directional and significant impact in both decision contexts: Older people and unmarried people donate more to the charities and allocate more money in the dictator game, whereas voters of the left party donate less and allocate less in the dictator game than all other individuals. The positive effect of individuals' household size on donations and dictator game allocations, however, is significant only for the latter. To sum up, the same individual characteristics seem to be crucial for generosity in both tasks.

7.5 Conclusions

The experiment presented in this chapter contributes to the discussion whether social preferences measured in the lab are predictive of individual behavior in other games or decision contexts. As opposed to the assumption of consistent preferences, the constructive-preference approach suggests that individuals construct their preferences ad hoc if they are confronted with an unfamiliar decision situation. The experiment takes a closer look at this issue as the experimental subjects have to allocate money in a conventional dictator game and make a donation decision. While the donation context represents a familiar decision situation where individuals are supposed to have existing

[58] More precisely, the cut-off threshold for donations is €22.16; the cut-off threshold for dictator game allocations is €12.88.

preferences, the dictator game is a rather unfamiliar decision situation where subjects are likely to construct their preferences ad hoc. Special attention is paid to the sequence in which both games are played by reversing their order to examine whether behavior in one situation is predictive of that in the other.

The results show that dictator game allocations are significantly higher if this game is played at the beginning of experimental sessions as compared to the dictator game played at the end of a session. Charitable donations, in comparison, are independent of the sequence of play. This more stable pattern may result from existing preferences in the donation context. Moreover, we observe a significantly positive correlation between charitable donations and dictator game allocations provided that individuals are confronted with the more familiar donation decision situation first. Hence, subjects are more likely to be consistently generous or selfish across games or contexts if they start the experiment with the more familiar decision problem. An explanation for this may be that they use the more familiar donation decision as an anchor for the subsequent dictator game decision leading to a higher degree of consistency across games. As this anchor is not available when the dictator game is played first, individual behavior is less consistent. This result is an indication for how preferences may be constructed in an experiment.

The discussion in this chapter suggests an important conclusion for the measurement of social preferences in lab experiments as it provides an explanation why some studies succeed and some studies fail to find a consistent behavioral pattern between a dictator game and different experimental task. It makes an enormous difference whether subjects in lab experiments find themselves in familiar decision situations or in unknown games, like the dictator game. Therefore, it is not so obvious in how far spontaneously constructed preferences can be predictive of behavior in other contexts or in real-life decision situations. In comparison, social preferences measured in more familiar decision contexts seem to have greater predictive power of behavior in other decision situations. Thus, experimenters trying to elicit social preferences in the lab should rather employ context-rich games where preferences exist and need not be constructed. The present experiment and previous literature have shown that the dictator game is particularly vulnerable to design changes and therefore not well suited for measuring social preferences. By adopting more robust tasks, such as a real donation decision, the measurement of social preferences within experiments may be improved.

Furthermore, special attention should be paid to the sequence of games if these present a new decision situation to the experimental subjects.

7.6 Appendix

7.6.1 Tables

Table 7.1: Treatments

Treatment	No. of charitable purposes	DG	Time of DG	No. of sessions	No. of subjects
NoDG	4	no		6	108
DGStart	4	yes	start	2	40
DGEnd	4	yes	end	4	75
Total				12	223

Table 7.2: Descriptive statistics

	No. of observations	Average donation (in €)	Average DG allocation (in €)
NoDG	108	5.72	-
DG	115	5.27	4.70
DGStart	40	6.25	6.25
DGEnd	75	4.76	3.87
Total	223	5.49	4.70

Table 7.3: Tobit estimation results

Variable	Including outliers		Excluding outliers	
	Charitable donation	DG allocation	Charitable donation	DG allocation
	(1)	(2)	(3)	(4)
age	0.253***	0.159***	0.229***	0.138***
	(0.082)	(0.050)	(0.066)	(0.044)
male	-2.134	-1.624	-1.839	-1.245
	(1.894)	(1.141)	(1.523)	(0.992)
household size	0.702	1.117	1.131	1.283**
	(1.131)	(0.676)	(0.902)	(0.583)
unmarried	9.132***	4.538***	7.873***	4.780***
	(2.830)	(1.693)	(2.264)	(1.476)
no_religion	1.002	-0.582	-1.166	0.021
	(2.074)	(1.257)	(1.684)	(1.084)
left_party	-8.734**	-3.638	-6.770**	-3.498*
	(3.944)	(2.306)	(3.106)	(1.981)
education	3.283	-0.315	1.526	0.735
	(2.107)	(1.284)	(1.691)	(1.126)
income	2.364	1.217	0.744	-0.354
	(2.271)	(1.378)	(1.826)	(1.231)
DGStart	0.929	2.827**	0.640	2.637***
	(1.900)	(1.142)	(1.533)	(1.002)
Constant	-15.368***	-8.274**	-12.719***	-8.150***
	(5.797)	(3.484)	(4.619)	(3.051)
No. of observations	98	98	96	96
LR Chi²	23.32***	25.20***	21.80***	27.20***
Pseudo R²	0.042	0.051	0.043	0.059

Notes: t statistics in parentheses; levels of significance: * p<0.10, ** p<0.05, *** p<0.01.

Table 7.4: Socio-demographic characteristics of participants

Variable	State	Frequency abs.	Frequency in %
Gender	Male	103	46.19
	Female	119	53.36
	No answer	1	0.45
Age	18 – 29	73	32.74
	30 – 44	60	26.91
	45 – 59	54	24.22
	60 – 75	34	15.25
	No answer	2	0.90
Family Status	Single	139	62.33
	Married	45	20.18
	Divorced	31	13.90
	Widowed	6	2.69
	No answer	2	0.90
Children	Yes	34	15.25
	No	189	84.75
Household size	1	102	45.74
	2	82	36.77
	3	21	9.42
	4 or more	17	7.62
	No answer	1	0.45
Education	University	88	39.46
	Gymnasium (12 years of education)	58	26.01
	Realschule (10 years of education)	35	15.70
	Hauptschule (9 years of education)	23	10.31
	Other	17	7.62
	No graduation	2	0.90
Nationality	German	192	86.10
	Turkish	2	0.90
	Italian	3	1.35
	Polish	2	0.90
	Other	23	10.31
	No answer	1	0.45
Household net income	< 1.000 €	51	22.87
	1.000 – 2.000 €	85	38.12
	2.000 – 3.000 €	44	19.73
	3.000 – 4.000 €	13	5.83
	4.000 – 5.000 €	8	3.59
	> 5.000 €	8	3.59
	No Answer	14	6.28
Religion	Catholic	70	31.39
	Evangelic	71	31.84
	Muslim	5	2.24
	Other	10	4.48
	No religion	67	30.04
Voting behavior	The Christian Democratic / Christian Social Union	43	19.28
	The Social Democratic Party	49	21.97
	The Greens	42	18.83
	The Free Democratic Party	25	11.21
	The Left Party	17	7.62
	Other	9	4.04
	Nonvoter	17	7.62
	No answer	21	9.42
	Σ	223	100.00

Table 7.5: Charitable giving habits of participants

Variable	State	Frequency abs.	Frequency in %
Donated before	Yes	189	84.75
	No	34	15.25
Modal charitable purpose[1]	Child or disabled care	46	20.63
	Emergency aid	12	5.38
	Medical research	13	5.83
	Church and religious purposes	11	4.93
	Environment or animal protection	32	14.35
	Development aid	39	17.49
	General (e.g. Red Cross, charitable lotteries)	20	8.97
	Culture	3	1.35
	Politics	2	0.90
	Local welfare services, homeless persons, poverty	8	3.59
	No answer (incl. 34 subjects who did not donate before)	37	16.59
Contribution receipt received	Always	60	26.91
	Mostly	36	16.14
	Sometimes	42	18.83
	Never	49	21.97
	No answer (incl. 34 subjects who did not donate before)	36	16.14
Donated in 2009	Yes	67	30.04
	No	156	69.96
	Σ	223	100.00

[1)] If subjects stated that they had donated before they were asked to which charity they donated most frequently. If subjects gave more than one answer the charity named first was included.

7.6.2 Figures

Figure 7.1: Distribution of dictator game allocations across treatments

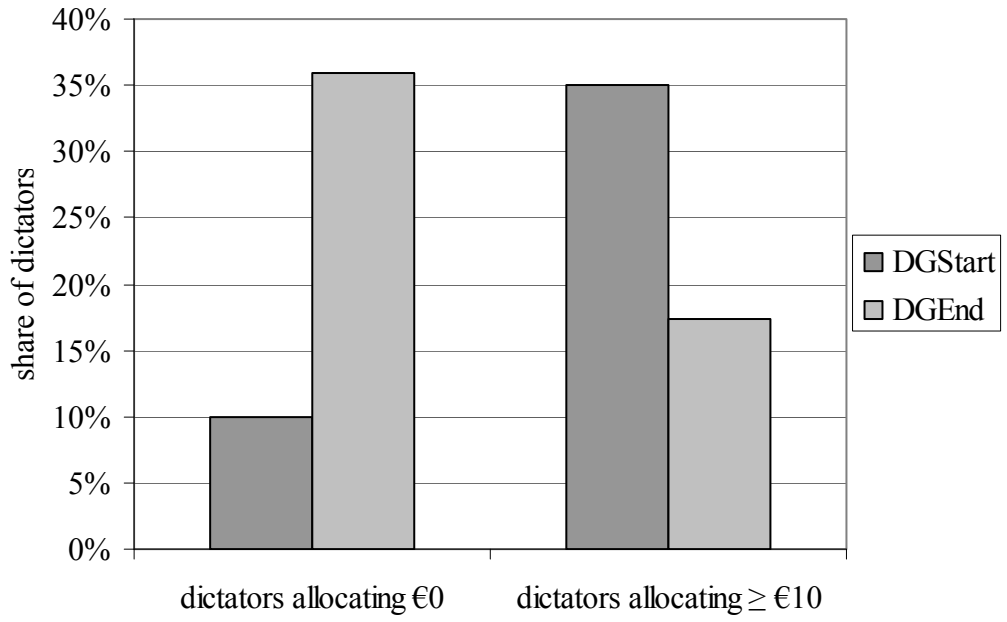
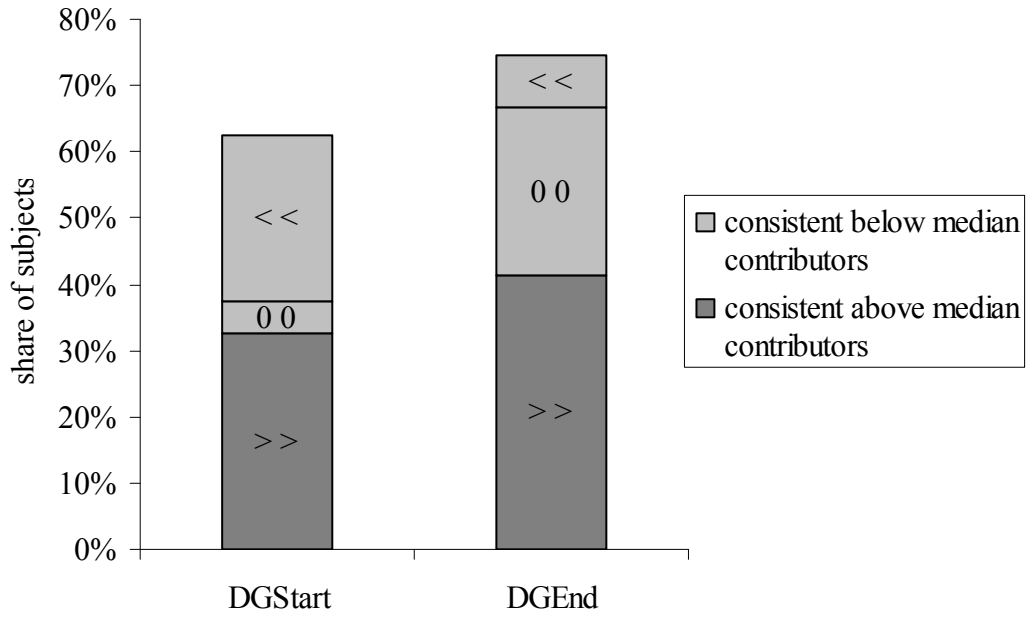
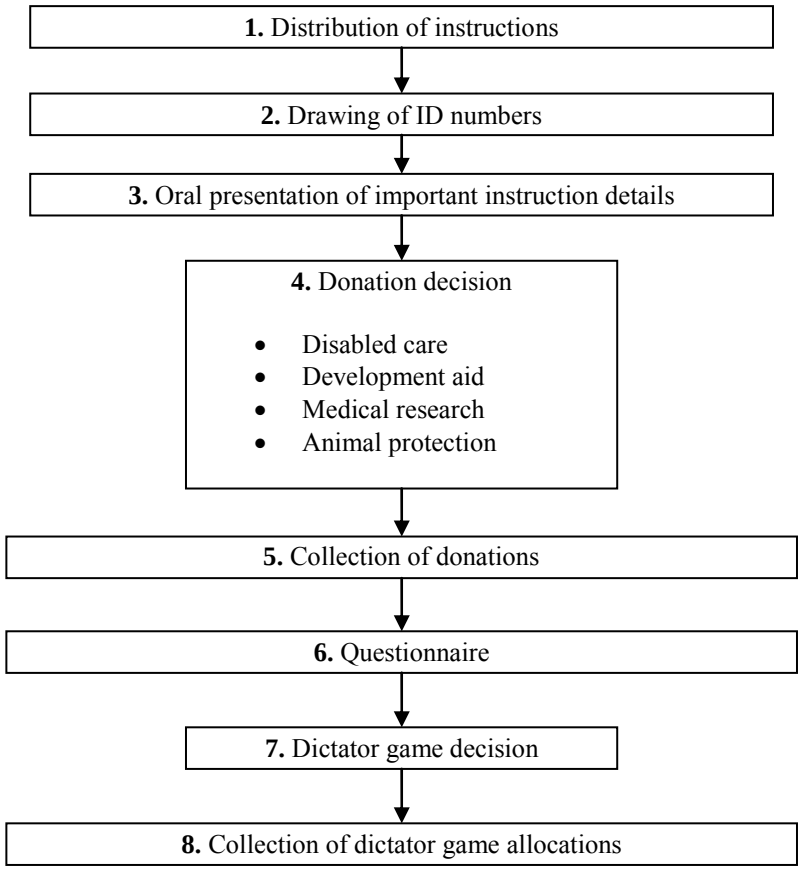


Figure 7.2: Consistent individual behavior across games



Note: >> - Contribution is above or equal to the respective relative median in both the donation and dictator game allocation decision. << - Contribution is below the respective relative median in both the donation and dictator game allocation decision, with at least one decision with non-zero contribution. 0 0 - Contribution is 0 in both the donation and dictator game allocation decision.

Figure 7.3: Proceeding of the experiment



Notes: The proceeding above reflects the *DGEnd* sessions. In the *DGStart* sessions the dictator game and the questionnaire were conducted before the donation stage. In the *NoDG* sessions no dictator game was played.

7.6.3 Experimental instructions

Experimental instructions for the *DGEnd* treatment (translated from German)

Welcome!

Thank you very much for participating in our study analyzing consumer behavior. Enclosed in this folder, you find information which you need throughout the study. You may return to pages you have already gone through at any time. Please do not look at the pages behind the next 'stop-sign'. You will be asked to turn to the next page. Please only read the respective text and do not act until you receive specific instructions to follow the assignment.

Please follow the instructions carefully. We also would like to ask you not to talk to other participants.

We want to emphasize that all information which we gain from today's event will only be used to draw a comparison between the groups of participants. No individual data about the participants will be published or passed on.

Shortly, we will come up to your seat and you will draw a piece of paper with a number on it. This number will serve as your personal identification number (ID) throughout the study. Please state your ID whenever you are asked to do so during the study. The ID ensures anonymity, as neither other participants nor we know your name or the ID that belongs to it.

-- STOP sign: Please do not turn the page until we ask you to! --

Part 1

You will receive 40 Euros for your participation in the study. Shortly, we will hand out the money in an envelope. Then we ask you to confirm the receipt. Afterwards, you will get the opportunity to donate any preferred amount of money to a charitable cause.

There is a charitable organization behind every charitable cause. The money you donate if you decide to donate any will be **completely** transferred to the respective charity. We guarantee that this will happen lawfully and will have the transfer supervised and verified by the director of the notary's office, Dr. Rainer Preusche.

All selected charitable organizations hold the 'donation seal' by the state-approved German Central Institute for Social Issues (Deutsches Zentralinstitut für soziale Fragen (DZI)). This assures that the organizations act autonomously and charitably and that the usage of their financial means is reviewable, economical and statutory. The names of the individual organizations will at this point – for scientific reasons – not be mentioned. We guarantee that all information you receive from us regarding the organizations is **true**. At the end of the experiment, we are happy to hand to you a list of all organizations upon request.

In the following, we present to you four different charitable causes to which you can donate in the course of this study.

The four charitable causes are:

- Medical research
- Animal protection
- Disabled care
- Development aid

We now hand out to you an envelope with the money you receive for your participation in our study.

-- STOP sign: Please do not turn the page until we ask you to! --

In the envelope, you find:

- one white envelope
- one blue envelope

- 40 Euros, composed of two 10 Euro-bills, one 5 Euro-bill, six 2 Euro-coins and three 1 Euro-coins
- one receipt.

We now ask you to sign the enclosed receipt. By doing so, you confirm that you have received 40 Euros from ZEW for the participation in this study. We need the receipt for administrative purposes. Without a receipt we are not allowed to give you the money. Your data is still handled **confidentially** and **anonymously**. We will now collect the receipts. The study will continue hereafter.

-- STOP sign: Please do not turn the page until we ask you to! --

Now you can make a donation decision. You can decide **freely and anonymously** whether and how much money you want to give to one of the above-mentioned charitable organizations. The amount of money you put in the **blue** envelope will benefit a charitable cause and will be transferred **completely** to the respective charity after the experiment. You can keep the amount of money you put in the **white** envelope.

The study proceeds as follows:

1.) Make your donation decision.

In case of a donation, please tick the desired charitable organization on the **blue** envelope. Please note that you have to choose **one** of the four [*in the Info treatment*: eight] given charities. It is not possible to choose more than one charitable organization for your donation. Please tick only **one** organization if you wish to donate. If you tick more than one organization, unfortunately, we will not be able to transfer the donation. If you do not wish to donate, please do not tick any organization.

2.) Write down your ID-number in the predefined box on the **blue** envelope, irrespective of whether you wish to donate or not.

3.) Put the desired donation amount in the **blue** envelope.

4.) Put the amount of money you wish to keep in the **white** envelope.

Finally, you should have distributed 40 Euros completely to the two envelopes. Please note that any distribution in full amounts of Euros is possible. You may put any desired amount of money into both envelopes. It is also possible to put 40 Euros completely into one envelope.

5.) Seal up **both** envelopes.

When all participants have finished, we will come up to you and collect the **blue** envelope. When we do so, please put the **blue** envelope into the box. Please keep the white envelope. We guarantee that your donation will be transferred to the charitable organization lawfully and have the transfer supervised and verified by the director of the notary's office, […].

We will explain the most important items once again orally. Afterwards, please make your decision as described above.

-- STOP sign: Please do not turn the page until we ask you to! --

Part 2 – Questionnaire

Please answer the following questions by ticking or filling out.

If you have a question, please raise your hand. We will come up to you and answer your question. Please do **not** say your question out loud and please do not talk to other participants.

1. What is your ID-number? _____

2. How can your marital status be described?

   O unmarried
   O married
   O divorced
   O widowed

3. Please state your gender:

   O male
   O female

4. What is your year of birth? _____

5. How many people, including you, live in your household?
   _____

6. How many children live in your household?

   O 0-3 years old _____
   O 4-7 years old _____
   O 8-12 years old _____
   O 13-18 years old _____
   O older than 18 years _____
   O none

7. What is your religious affiliation?

   O Catholic
   O Protestant
   O Muslim
   O Jewish
   O Buddhist
   O other: _____
   O no religion

8. What is your highest educational achievement?

   O University/College

O higher education entrance qualification
O middle school
O secondary modern school
O other: _____
O none

9. What is your original nationality?

O German
O Turkish
O Italian
O Polish
O other: _____

10. What is your first language? _____

11. What are the monthly net earnings of <u>your household</u> (how much money per month is available for your household <u>altogether</u>?)

O below 1,000 Euros
O 1,000 – 2,000 Euros
O 2,000 – 3,000 Euros
O 3,000 – 4,000 Euros
O 4,000 – 5,000 Euros
O above 5,000 Euros
O not specified

12. Which party would you vote for if there were federal elections this Sunday?

O CDU/CSU
O SPD
O Bündnis 90 / The Green Party
O FDP
O The Left
O Other
O I do not vote
O not specified

14. Have you made a donation to a charitable organization before?

O yes O no

15. To which purpose have you donated most often?

_____

16. Have you already donated to a charitable organization this year?

O yes O no

17. If you answered question 16 with ‘yes’, in which month have you donated last?

_____

18. If you answered question 16 with ‘yes’, how much have you donated this year altogether?

_____ €

19. Have you ever received a donation receipt for your donation?

O always

O mostly

O occasionally

O never

20. Compared with how others live in Germany: Do you think you get your fair share, more than your fair share, somewhat less or very much less than your fair share?

O fair share

O more than fair share

O somewhat less than fair share

O very much less than fair share

O don’t know

21. On the whole, I find the social differences in our country just.

O Completely agree.

O Tend to agree.

O Tend to disagree.

O Completely disagree.

O Don’t know

22. The State must ensure that people can live a decent income even in illness, hardship, unemployment and old age.

O Completely agree.

O Tend to agree.

O Tend to disagree.

O Completely disagree.

O Don’t know

23. It is the responsibility of the government to reduce the differences in income between people with high incomes and those with low incomes.

O Agree strongly.

O Agree.

O Neither agree nor disagree.

O Disagree.

O Disagree strongly.

O Can't choose.

-- STOP sign: Please do not turn the page until we ask you to! --

Part 3

The participants of our study can be divided into two groups of equal size, which we call group A and group B. All participants who join the same session will be randomly assigned to **one** of the groups.

Participants in group A will shortly receive a further envelope which contains 20 Euros. The participants receive these 20 Euros **in addition** to the 40 Euros which participants of both groups receive. Participants in group B will receive **no** additional money.

Each participant in group A has the chance to give any desired amount of their 20 Euros to a participant from group B which will be randomly assigned. To this end, the participant in group A puts money into an envelope, which will later be given to a participant in group B. At no time will the participants in group A know which participants in group B have received their envelopes. It also applies that at no time, any participant in group B will know which person in group A the envelope is from. The participant in group B will receive the envelope even in the case that there is no money in it.

Drawing of the group:

The session which you participate in has randomly been assigned to group A. Therefore, you are a member of group A and receive an additional 20 Euros.

[The session which you participate in has randomly been assigned to group B. Therefore you are a member of group B. We now hand out to you an envelope which comes from a randomly selected participant of group A.]

-- STOP sign: Please do not turn the page until we ask you to! --

[Group B continues with the option to give general comments on the study. The following instructions are received by group A only.]

In the envelope, you find:

- one white envelope
- one yellow envelope
- 20 Euros, consisting of two 5 Euro-bills, as well as two 2 Euro-coins and six 1 Euro-coins
- one receipt.

We now ask you to sign the receipt you find enclosed. By doing so, you confirm that you have received 20 Euros from ZEW. We only need the receipt for administrative

purposes. Without a receipt we are not allowed to give you the money. Your data is still handled **confidentially** and **anonymously**. We will now collect the receipts. The study will continue hereafter.

-- STOP sign: Please do not turn the page until we ask you to! --

Please distribute the 20 Euros to the white and the yellow envelope. You keep the amount of money you put in the **white** envelope. The amount you put in the **yellow** envelope will be given to a participant in group B, which will later be randomly chosen. This participant will receive the envelope at the end of their experiment even if there is no money in the it.

We guarantee that the transfer of the envelope will be carried out lawfully.

You make the decision whether and how much of the 20 Euros you want to distribute among you and an unknown participant **freely** and **anonymously**.

The study will be carried out in the following chronological order:

1.) Put the amount you wish to give to a participant of the experiment in the **yellow** envelope.

2.) Put the amount of money you wish to keep in the **white** envelope.

Finally, you should have distributed the 20 Euros completely to the two envelopes. Please note that any distribution in full amounts of Euros is possible. You may put any desired amount of money in both envelopes. It is also possible to put 20 Euros completely into one envelope.

3.) Write your ID-number in the predefined box on the **yellow** envelope.

4.) Seal up **both** envelopes.

When all participants have finished, we will come up to you and collect the **yellow** envelope. When we do so, please put the **yellow** envelope into the box. Please keep the **white** envelope.

We will explain the most important items once again orally. Afterwards, please make your decision as described above.

-- STOP sign: Please do not turn the page until we ask you to! --

We would like to ask you to write down general comments regarding our study. You *may* also give reasons for your donation decision. [11 empty lines follow.]

We would like to thank you for participating in our study and wish you a nice day! Please remember to take the white envelope with you.

8 General conclusions

Climate change has become a growing concern world-wide. The projected consequences include rising surface temperature, sea level rise, melting glaciers, changing precipitation patterns, increasing extreme weather events and changes in ecological and economic systems. However, climate change mitigation is a global public good and, therefore, suffers from underprovision due to strong free-riding incentives. The economics of climate protection – costs and benefits, uncertainty, and the regional distribution of effects – make the provision thereof one of the biggest challenges for the international community. Furthermore, the historical development of the problem and countries' differences in responsibility, wherewithal, and vulnerability give leeway for different perceptions of fair burden sharing.

As a consequence, only little has been done to actually mitigate global climate change so far. The Kyoto Protocol specified binding emission reduction obligations but failed to address the participation and enforcement problem properly. The Copenhagen Accord did not even attempt to implement binding reduction obligations but rather collected unilaterally declared pledges which cannot be expected to lead to significant changes in the atmospheric greenhouse gas concentration. These voluntary pledges were officially adopted in Cancún but the negotiations of an international agreement involving legally binding and long-term emission reduction target were postponed. The two largest CO_2 emitters worldwide, the United States and China, seem to have adopted an 'after you' strategy: Advocating that the other country was to take the lead in terms of timing and magnitude of emission reductions on the grounds of reciprocity considerations, they have managed to stay clear of any legally binding commitments to date. Many other industrialized countries or regions, such as the European Union, Japan, Australia, and New Zealand, also make stringent emission reduction targets conditional on other countries' actions. This strategy reflects the understanding that unilateral leadership will not have an effect on the global climate and that the climate change has to be addressed collectively.

This thesis provided an experimental and theory based analysis of the voluntary provision of global public goods with a special focus on climate change mitigation. The objective was to analyze both subjects' behavior in games designed to simulate climate change (*Part I*) and subjects' behavior in related games designed to elicit other-

regarding preferences (*Part II*). The first part examined the consequences of real (and possibly other-regarding) preferences for the subjects' ability to solve the dilemma or coordination problem. The second part addressed the question of how to elicit other-regarding preferences. It provided some methodological insights and an indication of other-regarding preferences of real policy makers and citizens. In the following, the main results of both parts are summarized.

Part I presented three public goods experiments conducted in the lab with students: Chapter 2 tested the voluntary formation of coalitions in a dilemma situation. The success of a coalition to overcome free-riding incentives depends on two interlinked challenges: On the one hand, the institutional arrangements need to attract signatories (extensive margin). On the other hand, any given coalition should be able to internalize the mutual benefits from the public good among its members (intensive margin). Different institutions were tested with respect to their ability to succeed along these two dimensions. The experimental results showed, on the one hand, that institutions which exogenously force members to fully internalize their mutual benefits generate a rather low participation rate, just as theoretically predicted. The resulting provision levels of the global public good do hardly go beyond the ones achieved by a purely voluntary contribution mechanism. On the other hand, lowering the degree of internalization of benefits within the coalition does not attract more members and, accordingly, does not generate efficiency gains. Benefits arise, however, from institutions which allow members to endogenously determine the terms of the agreement as they attract more members: The smallest common denominator rule, where each coalition member can suggest a provision level, knowing that the smallest suggested level is binding for all coalition members, generates larger coalition sizes and larger average contributions. Thus, there is a clear tradeoff between extensive and intensive margin: The larger the (endogenously determined) requirements from coalition members, the less willing subjects are to enter the coalition.

Chapter 3 provided further evidence on the effects of different negotiation procedures within a coalition. It shows the effects if signatories to an agreement apply qualified majority voting or simple majority voting to determine the terms of the agreement. The resulting public good provision and welfare levels were compared with those achieved by the smallest common denominator rule in which signatories apply a unanimity rule to determine their effort level. At first sight in line with theoretical predictions, the

experiment showed that a change of the voting scheme implemented in a coalition does not significantly change social welfare. However, changing the majority required to determine the terms of an agreement alters the depth and breadth of cooperation: The coalitions under the unanimity rule are relatively large and implement moderate effort levels, while the coalitions with majority votes implement very high effort levels but attract only few participants.

Chapter 4 explored the relevance of inequality and commitments issues in affecting subjects' ability to coordinate their efforts to avoid catastrophic climate change. The results showed that the real-world features introduced in the game have deep consequences on the cooperation level. Both claims that the inequality disrupts and the non-binding announcement of targets helps coordination were supported by the data. The experiment clearly showed the conditions under which subjects effectively coordinate their efforts to avoid the climate catastrophe: All successful groups agreed on a common equity notion and eliminated inequality completely while failing groups often disagreed about the reduction of inequality. In that context, the announcement of non-binding targets was particularly helpful to solve the coordination problem.

Part II addressed the question of how to elicit other-regarding preferences. It started with Chapter 5 analyzing in how far equity considerations are important to individuals involved in climate negotiations. Equity preferences were measured with the help of two simple non-strategic games which resembled the decisions in a dictator game and an ultimatum game. The main finding was that inequality is of considerable importance for climate negotiators. Despite the simplistic nature of the experiment, the individual preferences might serve as a starting point for a discussion of the role of equity for the cooperation of countries in climate policy. As a vast majority of participants expects governments not to act in a more equity-oriented way, the individual preferences may be seen as an upper bound for the equity concerns reflected in collective preferences of countries. Considering alternative groupings of countries such as G8 versus Non-G8 or EU versus Non-EU countries there are no significant differences, neither for individual preferences nor for expected collective preferences.

The experiments presented in Chapter 6 and Chapter 7 were not directly linked to climate change mitigation. They investigated the willingness to contribute to public goods in the context of charitable donations. Chapter 6 contributed to the understanding how the provision of information about charities' revenues affects individual donation

decisions. The experimental results show that donors prefer to give to small charities with relatively low revenues as compared to large charities. Thus, the results supported the models that predict a negative relation between a charity's income and the willingness to donate to that charity: the theory of impact philanthropy, which assumes that donors try to achieve the biggest impact possible with their charitable contribution, as well as those public goods models which predict incomplete crowding out of voluntary contributions by third-party contributions. The results furthermore confirmed previous findings that the individual donations increase with subjects' age, income, and education. This suggests that donation decisions in the experiment are a good indicator of real-life decisions. Unmarried individuals donate significantly more and voters of the left party donate significantly less than others.

Chapter 7 contributed to the discussion whether social preferences measured in the lab are predictive of individual behavior in other games or decision contexts. As opposed to the assumption of consistent preferences, the constructive-preference approach suggests that individuals construct their preferences ad hoc if they are confronted with an unfamiliar decision situation. The experiment took a closer look at this issue as the experimental subjects had to allocate money in a conventional dictator game and made a donation decision. While the donation context represents a familiar decision situation where individuals are supposed to have existing preferences, the dictator game is a rather unfamiliar decision situation where subjects are likely to construct their preferences ad hoc. The results show that dictator game allocations are significantly higher if this game is played at the beginning of experimental sessions as compared to the dictator game played at the end of a session. Charitable donations, in comparison, are independent from the sequence of play. This more stable pattern may result from existing preferences in the donation context. Moreover, we observed a significantly positive correlation between charitable donations and dictator game allocations provided that individuals are confronted with the more familiar donation decision situation first. Hence, subjects are more likely to be consistently generous or selfish across games or contexts if they start the experiment with the more familiar decision problem.

What are the general conclusions of all these experiments with regard to the central topic of this thesis – global climate change? Despite the fact that the experiments in the final two chapters had a message of their own for the economics of charitable donations and the elicitation of other-regarding preferences, they might also contribute to the debate on climate protection. First of all, they confirmed that the behavior of citizens in experimental games is comparable with that of students. They showed, furthermore, that people are willing to contribute to global public goods even if these goods benefit mainly foreigners. Recall that development aid was the second most common cause selected by experimental subjects. This suggested that people would also be willing to contribute to climate protection even if that did not inure to their own benefit but rather to the benefit of poor people living in developing countries. At the same time, people's donations were shown to be not purely altruistic but destined to satisfy own concerns as well. For example, donors try to achieve a large impact with their charitable contribution. Since the impact of individual contributions to climate protection is negligible, those people may choose another 'good cause' when facing an investment decision.

Similarly, the online experiment with climate negotiators indicated that policy makers' decisions in experimental games are in the range of students' behavior. It showed furthermore that policy makers care about foreign colleagues even under anonymous conditions. At the same time, the study showed that climate negotiators do not expect their government to be equally generous but more selfish. As mentioned in the introduction of the thesis, it is not possible to measure the preferences of countries. We can only collect empirical evidence of the preferences of voters, delegates, and government representatives in order to provide input for the further development of the theoretical models. This was an important goal of the experiments presented in the second part of the thesis. The results generally supported the hypothesis mentioned in the introduction that countries can be expected to act not completely selfishly but more selfishly than individuals.

This, in turn, confirmed the view that experimental findings should be taken into account in the analysis of climate negotiations and the respective policy advice (Weimann 2010). The experiments complement the theoretical analyses by showing the consequences of real preferences. Furthermore, they give an indication of human behavior where theory is ambiguous or blind and they are able to separate different

effects by using ceteris paribus comparisons. Hence, even if the experimental results cannot be transferred one-to-one to the real world, they provide valuable guidance for the evaluation of institutions with respect to their ability to secure the provision of a public good. An institution which neither works in theory nor in the lab is not likely to be helpful in reality – and vice versa.

Having said this, what can we learn from the climate change games presented in the first part of the thesis? Chapter 2 and Chapter 3 reported the effects of different institutions for the formation of coalitions. They showed that people in the lab do not always act in line with the theory, but all the same, they are still far away from the social optimum. Thus, both the theoretical models and the experimental games indicate that under certain circumstances, first-best solutions are not available. In Chapter 4, we saw that the prospect of catastrophic climate change fundamentally alters the cooperation challenge. As the challenge is one of coordinating efforts rather than cooperating just to increase the effort level, many groups succeeded in avoiding catastrophe, especially when a communication opportunity was available. Inequality impeded effective coordination indicating that equity and fairness are important issues in climate negotiations, which may not help but rather hamper cooperation. If countries cannot agree on a common fairness notion, the lack of consensus may easily lead to political lock-ins as described at the beginning of this section.

The implications of the experimental results are important for the ongoing policy discussions. A widespread view on the reason why climate negotiations have failed so far is that the problem was the *process*: The United Nations process involves nearly 200 countries. The decision under the rules of the Framework Convention must be unanimous which gives every country a veto. The common argument is that this veto together with clearly varying interests of countries impedes an effective global agreement. The experimental results presented here, however, are not in line with this assessment. They show that even small groups of few symmetric players are not able to reach an effective global agreement. The abolition of the veto, i.e. the introduction of majority voting, does not help to secure the efficient public good provision. The experimental results suggest instead that, first and foremost, the prevailing free-riding incentives are responsible for the failure to cooperate.

The experimental literature on the formation of international environmental agreements and the avoidance of catastrophic climate change is still at the beginning and needs further development. However, the experimental results so far support the view that small changes in the design of a particular agreement might not be enough but more radical changes might be needed. The 'targets and timetables' approach as implemented in all previous climate agreements does not show great promise for reducing global greenhouse gas emissions. The prospects for an effective global agreement are thin from all perspectives: real world experience, theory and experiments. This has three important consequences: First, countries are well advised to prepare for and adapt to climate change. Second, besides working on a first-best one-track agreement, they should aim for second-best solutions such as sectoral or small multi-track agreements. These institutions should be evaluated primarily according to their ability to address participation and compliance. This means on the one hand that they must be able to alleviate the free-riding incentives and, on the other, their distributional consequences must be acceptable for the relevant countries. Third, research and development and technological progress are essential to change the economics of climate protection and, therefore, to positively influence the prospects for a future global agreement.

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Hiermit erkläre ich, dass ich diese Dissertation selbständig verfasst und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Aussagen und Konzepte sind unter Angabe der Quelle gekennzeichnet.

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